SUGARBEET RESEARCH

1991 REPORT

FOREWARD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning research by Agricultural Research Service investigators and cooperators who are engaged in sugar beet variety and production research. The report has been assembled and reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of its members and the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor and the Beet Sugar Develepment Foundation.

The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association; and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

CONTENTS

CONTENTS

PAGE

CONTENTS

SUGARBEET RESEARCH

1991 Report

Section A

U.S. Agricultural Research Station, Salinas, California

Dr. J. E. Duffus, Plant Pathologist
Dr. L. L. Hoefert, Botanist
Dr. R. T. Lewellen, Geneticist
Dr. H. Y. Liu, Plant Pathologist
Dr. M. H. Yu, Geneticist
Dr. J. S. McFarlane, Collaborator

Cooperation:

Delta Sugar Company
Holly Sugar Company
Spreckels Sugar Division
California Beet Growers Association

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 210, 211, 212, 215, 203, and 260) and the California Beet Growers Association.

CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1991

BABB, T.A., J.L. KIMMELL, J.S. GERIK, and R.P. HEIMFORTH. Evaluation of 1,3-dichloropropene soil fumigation and tolerant varieties on California sugarbeet production in rhizomania-infested soils. Jour. of Sugar Beet Res. 28:62. 1991.

The production of sugarbeets (*Beta vulgaris* L.) is limited in California by the presence of rhizomania, a viral disease (beet necrotic yellow vein virus) transmitted by a fungus, *Polymyxa betae* Keskin. Trials in 1989 and 1990 evaluated the effect of tolerant varieties in combination with soil fumigation on sugarbeet yield in rhizomania-infested fields. A split-plot experimental design was used with main plots of 0, 9 & 12 gallons per acre (gpa) fumigation rates using 1,3-dichloropropene. Subplots were varieties with a range of tolerance to rhizomania. An attempt was made to quantify the inoculum density in each of three fields and relate it to subsequent yields. Main plots were applied in either October or April, and plots were planted in February or April. Yields varied between locations, with unfumigated plots ranging from 0.45 tons of sugar per acre (TS/A) for a susceptible variety to 1.16 TS/A for a tolerant variety. The highest yielding tolerant variety yielded 3.3 TS/A in 1989 with 12 gpa of 1,3-dichloropropene. Results suggest varietal tolerance presently available is not sufficient to profitably produce sugarbeets in fields infested with rhizomania without soil fumigation. The success of a tolerant variety in combination with soil fumigation may be dependent on the original inoculum density in a field. A technique to rapidly assay soil for disease inoculum levels would aid California growers in determining which field will produce economic returns when combined with soil fumigation and an adapted, rhizomania tolerant variety.

BAÑUELOS, G.S., S. TEBBETS, R. PERRY, J.E. DUFFUS, and P. VAIL. The potential of non-native selenium accumulating mustard plants as host for beet leafhopper and beet curly top virus. Southwestern Entomology (In Press). 1992.

Agricultural irrigation/drainage problems in the westside of central California have resulted in public concern after scientists determined that excessively high concentrations of naturally-occurring selenium (Se) accumulated in the food chain and caused deformities and reproductive problems in wildfowl (Presser and Barnes 1985, Ohlendorf et al. 1986). Consequently, environmentally sound approaches to control the amount of Se entering the agriculture ecosystem are being studied. Two

suggested plans for managing drainage-induced Se problems include reusing drainage water for irrigation where possible (Rhoades et al. 1989, Ayers et al. 1987) or using a recently introduced exotic species of mustard from Pakistan, *Brassic juncea* Czern L., to remove Se from the soil (Bañuelos and Schrale 1989). Because *B.juncea* is able to absorb high concentrations of soluble Se from the soil (Bañuelos and Meek 1990), interest exists in its potential for Se removal in central California. However, there is also concern that test plantings of native and/or non-native plant species might contribute to beet curly top virus (BCTV) dissemination by serving as host plants or harboring insect vectors.

In North America, the beet leafhopper, *Circulifer tenellus* (Baker), feeds in the phloem cells of dicotyledonous plants (Magyarosy and Duffus 1977). Many plant species serve as host to BCTV including field crops such as sugarbeets, tomatoes, cantaloupe, spinach, beans, and many ornamentals (Mumford 1982). In late fall, as food crops are harvested and the favored weed hosts are drying, insects colonize alternate host plants for food and shelter.

The beet leafhopper overwinters on weed hosts in central California. Much is known about the weed host range of the beet leafhopper and BCTV (Bennett 1971), and comparisons between major weeds as hosts for beet leafhopper and BCTV have been made in central California (Mumford and Doney 1984) and elsewhere (Gracia and Feldman 1972). It is necessary therefore to determine any relationship between beet leafhoppers, BCTV, and this exotic mustard before planting area-wide to facilitate Se removal. Accordingly, planting of *B.juncea* located adjacent to different agronomic crops in central California were sampled for beet leafhopper during the summer of 1990. In addition, *B.juncea* was experimentally inoculated with the BCTV, and the virus's rate of spread monitored with the enzyme-linked immunosorbent assay (ELISA).

Field experiments were conducted in west-central California between 15 May and 1 September 1990. *Brassica juncea* Czern L. was planted on three different field sites in two-week intervals: (1) site 1, located 25 km southwest of Fresno, consisted of a 0.1-ha parcel 25 m from corn and birdsfoot trefoil; (2) site 2, located 10 km west of Los Baños, consisted of six 0.05-ha parcels 50 m from cotton and ornamental eucalyptus; (3) site 3, located in the northeast sector of Fresno on California State University Fresno, consisted of a 0.1-ha parcel 25 m from turf and peach trees.

Two-week old *B.juncea* seedlings were transplanted to each growing site on beds spaced 15 cm apart. Plants were irrigated similarly to the crops grown near each respective site.

Eighteen days after transplanting, the plants were sampled for leafhoppers at 10 A.M. using an insect sweep net. Each sample consisted of eight random sweeps progressing from the outside towards the middle of the plot. Collected insects were placed into a glass jar and frozen for later identification. A total of four samples, 12 days apart, were collected at each field site.

Both *Brassica juncea* and *Brassica alba* (a mustard native to California) were inoculated with different strains of BCTV (Logan, St-11, Fresno I and HRCT) and then monitored for BCTV by serological methods (ELISA) (Mumford 1982). In addition to normal inoculation procedures (10 leafhoppers/plant with a 3 to 4-day inoculation feeding period), a large number of viruliferous leafhoppers (100) were colonized on test plants for 10 days; adults were removed and developing nymphs were monitored for BCTV.

During the study we collected insects representing 10 orders and over 22 families (data not shown). *Circulifer tenellus* was taken from all three test mustard plots; however, a total of only thirteen beet leafjoppers were found at site 1, three at site 2, and twelve at site 3. A few specimens of two other leafhopper species were also collected: *Macrosteles quadralineatus* Forbes, the aster leafhopper, and an unidentified species in the genus *Empoasca*.

In the inoculation experiments, BCTV was not detected in beet leafhoppers after an acquisition period of 3-4 days on BCTV-inoculated mustard plants and also was not detected in developing nymphs after an acquistion period of 10 days. In addition, test plants assayed for the BCTV virus ELISA were negative. Similar tests with *B.alba*, a known susceptible mustard host, produced positive results.

Several weeds, may of which are used by various insects as overwintering habitats, have been reported to be hosts of curly top virus (Gracia and Feldman 1972, Mumford and Doney 1984). The only insect vector of curly top virus described to date has been the beet leafhopper, which can undergo three or four generations per year in California (Magyarosy and Duffus 1977). According to Mumford (1982), an abundance of viruliferous leafhoppers is essential to cause a severe outbreak of curly top virus diesase; our sampling detected relatively low numbers feeding on wild brown mustard during the study. Even after inoculation of wild mustard with BCTV, nymphs collected from leafhoppers feeding on inoculated *B.juncea* did not exhibit a positive reaction to the virus with the ELISA technique. In addition, the virus was not recovered in the plant tissue. Thus, the exotic *B.juncea* was shown to be a nonhost plant for BCTV, even though the same inoculationn produced ELISA

positive plants and the virus was recovered in *B.alba*. Increased cultivation of *B.juncea* along the western margin of the San Joaquin Valley in central California, where naturally high concentrations of Se are present, will modify vegetation in certain isolated areas and may influence insect patterns. If damaging levels of beet leafhopper were to occur on these plantings, control measures, including insecticide applications might be necessary. However, multiple harvests of mustard plantings will be made during the year to remove Se accumulated in the plants. Repeated harvests would decrease population densities and reproductive capacities of beet leafhoppers and other insects. Our tests provide presumptive evidence that *B.juncea* Czern is a nonhost of BCTV under greenhouse conditions. Therefore, even if this plant becomes attractive to beet leafhopper, it is doubtful that the potential for outbreak of BCTV disease would increase due to plantings of this exotic brown mustard for the purpose of Se removal from the soil.

COHEN, S., J.E. DUFFUS, and H.Y. LIU. A new *Bemisia tabaci* biotype in the southwestern United States and its role in silverleaf of squash and transmission of lettuce infectious yellows virus. Phytopathology 82:86-90. 1992.

Collections of *Bemisia tabaci* from California desert regions have been shown to be a mixture of biotypes. These whitefly biotypes differ in a number of ways including their ability to induce silverleaf of squash. The physiological differences of the newly found whitefly biotype, including host preference, larval development, transmission of lettuce infectious yellows virus, and the induction of silverleaf symptoms, clearly distinguish it from the previously occurring biotype. Silverleaf of squash was induced by nymphal feeding activity; however, the physiological condition of the host as influenced by light intensity, quality, and duration are important factors in silverleaf expression. Differences between the whitefly biotypes in induction of silverleaf are quantitative and qualitative. Double-stranded RNA bands were not detected from nymph-infested leaves or from silverleaf symptomatic tissue, suggesting that whitefly-induced silverleaf in California is similar to a systemic phytotoxemia.

COHEN, S., J.E. DUFFUS, H.Y. LIU, and R. PERRY. Induction of silverleaf of squash by *Bemisia* whitefly from California desert whitefly populations. Plant Dis. 75-862. 1991.

The silverleaf syndrome in squash, induced by the feeding of the sweet potato whitefly [*Bemisia tabaci* (Gennadius)], is widespread in Florida. Populations of *B. tabaci* from the desert southwest have previously not been capable of inducing typical silverleaf. Recent isolations of *B.tabaci* from

California desert regions have shown that these populations are a mixture of biotypes. These whitefly biotypes differ in a number of ways including their ability to induce silverleaf of squash. The physiological differences of the newly introduced whitefly biotype, including host preference, larval development and the induction of silverleaf symptoms, clearly distinguish it from the common biotype. Double-stranded RNA bands were not detected from nymph-infested leaves or from symptomatic tissue, suggesting that whitefly induced silverleaf in California is similar to a systemic phytotoxemia. The occurrence of the silverleaf inducing whitefly biotype on nursery stock, including poinsettia and hibiscus, in various parts of the state, and the movement of such nursery stock from Florida to California, is the probable vehicle of the introduction of this new disease problem in California.

DUFFUS, J.E., and R.T. LEWELLEN. Planting and harvesting alterations for the control of lettuce infectious yellows virus. Jour. Sugar Beet Res. 28:67. 1991.

Lettuce infectious yellows virus (LIYV) has become a major disease inducing agent of sugarbeet in the southwest desert region of U.S.A. Losses as high as 20-30% have been reported. Monitoring of whitefly (*Bemisia tabaci*) populations and LIYV incidence indicate that they peak in August through October. The effects of altering planting and harvesting dates on whitefly incidence, LIYV incidence and sugarbeet yield were studied in an effort to design an agronomic control for the disease. Young plants at each observation had significantly higher whitefly numbers. There was a significant decrease in whitefly populations as the season progressed. This resulted in progressively less infection at the later planting dates. The cultivar US H11 had a higher infection rate than HH 41. The percentage of infection on US H11 was 45% at the late August planting date and was 12% at the late October planting date. Gross sugar yields under these relatively light infection rates were greater with increased growing periods indicating that delayed planting under relatively light LIYV infection pressure is of no value.

DUFFUS, J.E., S. COHEN, and H.Y. LIU. A new *Bemisia* whitefly biotype in the desert southwest and its role in systemic phytotoxemia and virus transmission. Phytopathology 81:1157. 1991.

Bemisia whitefly transmitted virus diseases have caused staggering losses to desert southwest agriculture since 1981.

In Florida, since about 1987, whitefly populations increased greatly and induced large losses to squash and tomato growers. These losses have been attributed to factors involved in whitefly feeding. Whitefly populations from the southwest desert collected in the fall of 1990 are a mixture of biotypes. The original biotype does not induce systemic phytotoxemia on squash, broccoli and other crops under natural conditions; whereas the newly found biotype does. Physiological differences in host preference, larval development and phytotoxemia clearly distinguish the biotypes. The biotypes differ significantly in their abilities to transmit viruses and this may explain epidemiological differences between *Bemisia* transmitted viruses occurring in various places in the world.

DUFFUS, J. E., and H.Y. LIU. Unique beet western yellows virus isolates from California and Texas. Jour. Sugar Beet Res. 28:68. 1991.

Yellowing virus isolates collected in California and Texas have been shown to have unique biological properties. They are very similar to "mild isolates" of the beet yellows virus (BYV) as reported in the late 1940's and early 1950's from Europe and U.S.A. The mild yellow- ing isolates produce only mild inter-veinal reddening symptoms on the BYV indicator *Chenopodium capitatum*, they have a host range which includes common indicator species of BYV, they are not mechanically transmitted as are severe BYV isolates, they do not cross protect against subsequent inoculation by severe BYV isolates, and they are serologically unrelated to severe BYV isolates. Insect trans-mission, host range studies, virus purification and serology have shown that these isolates are not mild isolates of BYV but are unique isolates of beet western yellows virus (BWYV). Most commonly found BWYV isolates from beet have a wide host range and are readily distinguished from BYV by "diagnostic" infection of *Capsella bursa-pastoris* and lack of infection of *Chenopodium capitatum*. These newly described isolates of BWYV do not affect *Capsella* but cause symptoms on *Chenopodium*. These "new" biological types may be more damaging to sugarbeet but may be more readily controlled by host-free periods than conventional BWYV strains.

DUFFUS, J. E., R. PERRY, H.Y. LIU, and C.WATSON. Susceptibility of *Atriplex* sp. to beet curly top virus. Jour. Sugar Beet Res. 28:68. 1991

Atriplex sp. are being evaluated in California by several government groups as a forage crop when irrigated with saline drainage water. *Atriplex*, a salt loving plant, has an

affinity for selenium. Perennial species are used as a multi-clipped forage crop and fed to selenium deficient cattle. Most *Atriplex* sp., reported in the literature of the 1920's, have been susceptible to beet curly top virus (BCTV) and may act as virus and vector (beet leafhopper) reservoirs.

Atriplex sp. found to be most promising (productivity, forage quality and agronomic characteristics) were evaluated as beet leafhopper hosts and for BCTV susceptibility. *A. barclayana*, *A. camarones*, *A. canescens*, *A. canescens* subsp. *macropoda*, *A. cinera*, *A. deserticola*, *A. halimus*, *A. nummularia*, and *A. sagittifolia* were all found to be poor hosts of the beet leafhopper and were not hosts of BCTV. The utilization of these species should not be considered as threats to curly top control efforts. A reevaluation of the host range of BCTV is probably justified.

DUFFUS, J.E., and E.G. RUPPEL. Sugarbeet diseases in the sugar beet crop. D.A. Cooke and R.K. Scott, ed., Chapman and Hall (In Press). 1992. (Book Chapter).

Diseases have played an extremely important role in the current distribution of sugar beet and its success as an agricultural crop. The sugar beet, a product of science, has depended upon in large measure the success of science in the control of destructive plant diseases.

The sugar beet introduced from Europe to wildly divergent areas of the world encountered numerous diseases unknown in its areas of development. The beet curly top virus virtually destroyed the sugar beet industry in the western United States in the 1920's and continued to be the principal factor limiting production, in this region, until the 1940's. In the absence of control measures, resistance and agronomic, sugar beet could only be grown in limited areas of western U.S.

Yellow wilt, first observed in Argentina in the 1920's, caused the complete collapse of the industry in that country and has severely limited the distribution of sugar beet in Chile.

In attempts to extend the cane sugar factory operations in southern U.S., sugar beet plantings were a complete failure due to two rots, *Rhizoctonia* crown rot and Sclerotium root rot.

Rhizomania was first discovered in the mid 1950's on the Po River Plains of Italy. By 1964 the disease had infested over 27,000 acres and caused their abandonment to sugar beet production. The disease discovered in California in 1983 has already been found in over 80,000 acres, has caused some areas to go out

of beet production, and has seriously altered production in other regions.

This book chapter discusses the major and minor virus diseases, fungal diseases and diseases caused by bacterial and bacteria-like organism.

FAIL, G.L., and L.L. HOEFERT. Electron microscopy of sugarbeet leaves infected with Beet Distortion Mosaic Virus. Jour. of Sugar Beet Res. 28:69. 1991.

Beet Distortion Mosaic Virus (BDMV), a soil-transmitted virus from the Texas panhandle, causes mosaic symptoms and hyperplasia of leaf mesophyll cells that externally appear as leaf distortions. Particles have flexuous rods which range in length from 650 nm (in leaf dips) to 2,000 nm (in purified samples). BDMV can be mechanically transmitted to several species in the Chenopodiaceae, and to *Gomphrena globosa*, in the Amaranthaceae. Infections may be limited to local lesions, or may be systemic. The development of virus inclusions has been studied in systemic infections of sugar beet, spinach, and *G.globosa*. Initial examinations used light microscopy of unfixed tissues stained with Azure A. Infected plant tissues contained inclusion bodies in mesophyll and phloem. Electron microscopy showed that the inclusion bodies were composed of tightly packed bundles of virus particles, which commonly attached to the outer membranes of chloroplasts. Vesicles similar to thos described in closterovirus infections were present in advanced infections.

GERIK, J.S., and T.A. BABB. Inoculum density of *Polymyxa betae* and beet necrotic yellow vein virus in soils from California sugarbeet fields fumigated and not fumigated with 1,3-dichloropropene. Jour. of Sugar Beet Res. 28:71. 1991.

Soil was collected from several sugarbeet fields in California and were assayed for the number of infecting units of *Polymyxa betae* and beet necrotic yellow vein virus (BNYVV) using a most probably number (MPN) technique. This technique requires that the soils be diluted, in a systematic manner, with sterile soil, past a point were the pathogens can no longer be detected. The soil dilutions required for the MPN technique were made using aliquots of the soil to be assayed which had been sterilized in an autoclave. The culture of bait plants in the diluted soils was accomplished in 24 well tissue culture plates, as described by Ciafardini and Marotta (Appl. Environ. Microbiol.: 1273-1278, 1989). Roots of the bait plants were assayed visually for *P.betae* and tested by ELISA for infection by BNYVV. These

assays provide information as to the inoculum density in sugarbeet fields known to be heavily infested with *P.betae* and BNYVV. Additional studies were conducted with soil collected from 2 field plots fumigated with 0, 9 or 12 gallons/acre of 1,3-dichloropropene. These plots were designed as randomized complete blocks, and random soil samples were collected from each plot. Soil samples were assayed for number of infecting units of *P.betae* and BNYVV using the MPN technique. These assays provide information as to the effect of 1,3-dichloropropene on the population of *P.betae* and BNYVV.

GERIK, J.S., and S.R. TEMPLE. Comparison of direct seeding and seedling transplanting on yield loss in sugarbeet due to rhizomania. Jour. of Sugar Beet Res. 28:71. 1991.

Fumigation with 1,3-dichloropropene has been a successful control strategy for rhizomania in the spring plant - spring harvest area of California. The fumigant apparently reduces the soil population of *Polymyxa betae* to low levels, thereby protecting the taproot until the time when this tissue is no longer susceptible. Only primary tissues, the epidermal and cortical cells, are susceptible to infection by *P.betae*. As the sugar beet tap root emerges from the seed and grows through the soil it is susceptible and may be killed, until the cortex is sloughed and secondary growth commences. By the end of the summer feeder roots may be nearly 100% infected, but as the soil temperature drops in the fall of the year, infection is much reduced and the infected sugarbeets will recover and produce a near normal crop the following spring. Experiments were conducted to determine the effect of seedling transplanting on yield loss caused by rhizomania. Four sugarbeet varieties, susceptible or tolerant, were planted or transplanted, in a split plot in a field known to be heavily infested with the rhizomania pathogens. Observations made during the growing season indicated that the transplanted sugarbeets remained healthier than the direct seeded ones. The experiment implies that transplanting sugarbeets may diminish the amount of damage caused by rhizomania and that transplanting could be a substitute for soil fumigation in an integrated control strategy.

HOEFERT, L.L., and S.S. MARTIN. Trap crops for the sugarbeet cyst nematode (*Heterodera schachtii*), I, Structure. Jour. of Sugar Beet Res. 28:75. 1991.

Nematodes are attached to some members of the Brassicaceae, notably species of Radish, and *Sinapis*. The plants have been widely planted in Europe as cover crops to aid in the attraction and removal of nematodes from sugarbeet fields. The techniques have met with considerable success abroad. Our approach has been

to look at the seeds and seedlings of the trap crops to see if any structural anomalies may exist that could explain the attraction of nematodes to the cover crops. We have begun the investigation into the distribution of specialized cells in seedlings and dry seeds during hydration. Quantitative data have been collected that indicate higher numbers of specializd cells occur in non-trap crop Brassicaceae species but that the size of the specialized cells is greater in trap crop species. Electron microscopy during development shows that the specialized cells differentiate in a manner similar to laticifers in latex-bearing plants, but that the cell content differs. In the specialized cells, glucosinolates or their precursors accumulate via endoplasmic reticulum cisternae that fuse with the central vacuole to produce a cell lumen filled with the glucosinolate materials.

HUBBARD, J.C., and J.S. GERIK. Temperature optima of California isolates of *Polymyxa betae*. Jour. of Beet Sugar Res. 28:75. 1991.

Isolates of *Polymyxa betae* were collected from sugarbeet production fields in California. Cultures of these isolates were initiated using multiple resting spore clusters collected with a micromanipulator and added to pots of sterile sand in which sugarbeet seedlings were grown. Dried root tissue from these plants, containing resting spores of *P.betae*, was used to inoculate sugarbeet seedlings growing in 4" pots. Inoculated plants were grown in growth chambers for 8 weeks at 16, 20, 24, or 28 C, and root samples taken from the pots were assayed for the amount of infection by *P.betae* using a modification of the procedure developed for quantification of vesicular-arbuscular mycorrhizae. The data indicate that the highest infection rate for *P.betae* occurs near 24 C, but one isolate from the Imperial Valley in California showed bimodal temperature optima, suggesting a mixed population of *P.betae* in that isolate. Further studies were conducted using single resting spore isolates of the above cultures established by the agar disk method and maintained on sugarbeets growing in sterile sand in a growth chamber. Zoospores collected from these cultures were used to inoculate further temperature experiments. The data from these studies will be discussed in conjunction with environmental data collected from areas of California where rhizomania is and is not a serious problem.

LEWELLEN, R.T., and I.O. SKOYEN. Improvement and performance of populations of sugarbeet x *Betamaritima*. Jour. of Sugar Beet Res. 28:79. 1991.

As a consequence of its rather narrow genetic base, sugarbeet (*Beta vulgaris* L.) has been highly vulnerable to endemic

diseases and pests, particularly in warmer and/or more humid environments. *B. maritima* is believed to be its ancestral species and should be an important and useful germplasm resource. An advanced sugarbeet breeding line was crossed to 59 accessions of *B. maritima* from the pre-1980 USDA collection. Individual F_1 and F_2 lines from each *B. maritima* accession were produced. Mother roots from the F_2 lines grown in a field plot were selected based upon nonbolting and agronomic type and composited to produce an F_3 population. The F_3 source and cycle 1 and 2 synthetics from it were evaluated in comparison to the sugarbeet parental line. Genetic variability was obvious in the sugarbeet x *B. maritima* populations for most traits examined. Selections for resistance to beet yellows virus and rhizomania based upon individual plant performance for sugar yield and root conformation significantly increased the performance of the respective synthetic when grown under diseased conditions. Even under mild disease exposure, the selected synthetics were superior to the F_3 source. The data suggested that an improvement for root and sugar yield also occurred. Compared to the sugarbeet parental line, root and sugar yield was higher but sucrose content and quality traits were poorer.

LEWELLEN, R.T., and I.O. SKOYEN. <u>Screening for bolting tendency within sugarbeet populations</u>. Jour. of Sugar Beet Res. 28:79. 1991.

It may be feasible to use a nonbolting, annual (*BB*), CMS inbred line of sugarbeet (*Beta vulgaris* L.) as a tester to evaluate and screen genotypes for bolting tendency. Based upon tests involving lines with known but extremes in bolting tendency, a good association occurred between the lines in overwintered tests and their corresponding annual testcrosses under long-day greenhouse conditions. It remained uncertain whether this evaluation procedure would be critical enough to sort genotypes within a breeding line. Plants from two lines were randomly selected, selfed to produce S_1 lines and crossed to annual C600CMS. S_2 lines were obtained from some S_1 lines. Annual testcrosses were evaluated for bolting in greenhouse and field tests under long-day conditions. Biennial S_1 and S_2 lines were evaluated for bolting in conventional fall planted field trials. Testcrosses evaluated in the greenhouse showed wide dispersion for bolting but not when tested under long-day field conditions. S_1 lines in an over-wintered test ranged from 0 to 91% bolted. Bolting tendency of S_2 lines had good association with their S_1 source but continued to show wide differences within sets from a common S_1 line. The testcrosses evaluated in the greenhouse showed agreement with their corresponding S_1 and S_2 lines evaluated under overwintered conditions, but there were

some major discrepancies. Usually though, the very slow bolting testcrosses identified the very nonbolting S_1 lines and S_2 lines that showed little additional segregation for bolting.

LEWELLEN, R.T., and S.R. TEMPLE. Response of sugarbeet line C31/6 to selection for resistance to beet yellows virus. Jour. of Sugar Beet Res. 28:79. 1991.

Beet yellows virus (BYV) continues to plague sugarbeet growers and processors in the Central Valley of California. Partially resistant or tolerant breeding lines that have been developed at Salinas over the past 35 years reduce the losses caused by BYV; however, higher levels of resistance in more productive backgrounds would be highly desirable. From moderately resistant breeding line C31/6, 100 half-sib families were evaluated for yield under BYV infected conditions at Davis and Salinas to determine if additional progress for resistance or performance under BYV conditions could be made. A wide dispersion for sugar yield occurred at both Davis and Salinas, but the rank correlation was poor. Six half-sib families were selected and individually advanced. Based upon data from each site, separate cycle 1 (C1) synthetics from a 10% selection intensity were made. Corresponding hybrids were produced with the source, C1 synthetics, and advanced lines. These were evaluated at Salinas and Davis in 1990 under BYV infected and noninfected conditions. The performance and resistance (% loss) of the source and C1 synthetics were not significantly different. Differences did occur among the six lines and their hybrids. The relative performance of the progenies and lines at Davis and Salinas suggested that location effects were important.

MARTIN, S.S., and L.L. HOEFERT. Glucosinolate biochemistry and structure of trap crops for the sugarbeet cyst nematode (*Heterodera schachtii*). Suppl. to Amer. Jour. of Botany. 78:142. 1991.

Selected cultivars of *Raphanus sativus* or *Sinapis alba* (Brassicaceae) induce cyst hatching and attract larvae of the sugarbeet cyst nematode, but disrupt normal reproduction. Such plants can be used as "trap" crops to reduce field nematode levels. As part of a study of the mode of action of these nematode-trapping plants, we compared the distribution of specialized glucosinolate-containing cells (GCCs) in seedlings of trap- and nontrap-crop cultivars of *R.sativus* and *S.alba*, and determined quantitative glucosinolate (GSL) profiles in seeds and developing seedlings. Structural studies

were made by light and electron microscopy. For biochemical work, tissues were extracted in boiling 75% methanol; intact glucosinolates were analyzed by HPLC [C_{18}-column; gradient elution with mixtures of 0.1M (aq.) ammonium acetate and acetonitrile] with photodiode array UV detection. In specialized GCCs, GSLs or precursors accumulated *via* endoplasmic reticulum cisternae that fused with the central vacuole to produce a cell lumen filled with biochemical material. Number and distribution of GCCs differed between trap and non-trap cultivars. All *S.alba* samples contained mainly 4-hydroxybenzyl-GSL (glucosinalbin), with small amounts of three other GSLs. Seed of *R.sativus* contained 4-methylsulfinylbut-3-enyl-GSL as the predominant GSL; germinating seedlings rapidly synthesized 4-methylthiobut-3-enyl-GSL, with several other GSLs present in lesser amounts.

SAUNDERS, W., P. DOLEY, G. ACQUAAH, and M.H. YU. Isoenzyme fingerprinting and in vitro shoot multiplication in Beta lomatogona Fisc. et Mey. ASSBT 26th Bienn. Meet. Abstr. p. 36. 1991.

The apomixis existing within Beta lomatogona Fisc. et Mey. might be very useful in developmnet of true breeding high performance hybrid sugarbeet cultivars if it can be transferred into B. vulgaris L. and harnessed in breeding programs. We studied isoenzyme fingerprinting and in vitro propagation as tools to identify apomictic and interspecific progeny and to clone individual genotypes, respectively. Variation among six accessions was seen with malate dehydrogenase (MDH), isocitrate dehydrogenase, shikimate dehydrogenase, phosphoglucomutase, and phosphoglucoisomerase but not with 6-phosphoglucose dehydrogenase. One accession had a unique MDH pattern. Some patterns were different from those found in sugarbeet. In vitro multiplication of shoots of three accessions was achieved starting with floral stalk axillary buds and using 6-benzyladenine as the sole growth regulator. 3.0 mg/L was the optimum concentration for overall shoot enlargement and multiplication. This is ten fold higher than routinely found for sugarbeet. This research indicated that isoenzyme fingerprinting and in vitro shoot multiplication could be used in genetic studies with Beta lomatogona and presumable with interspecific hybridization derivatives with sugarbeet.

SORIA, C., M.L. GOMEZ-GUILLAMON, and J.E. DUFFUS. Transmission of the agent causing a melon yellowing disease by the greenhouse whitefly *Trialeurodes vaporariorum* in southeast Spain. Neth. Jour. of Plant Pathol. 97:289-296. 1991.

The agent causing a yellowing disease of melon (Cucumis melo),

which results in severe losses in crops under plastic on the coastal plains of Southeast Spain, was shown to be transmitted in a semipersistent manner by the greenhouse whitefly (Trialeurodes vaporariorum Westwood). The agent was transmitted by grafting, but not by mechanical inoculation or through seeds. The agent was acquired in the minimum period tested (2 h.) and could infect plants in an infection feeding interval of 6 h.

Capsella bursa-pastoris, C. melo, C. sativus, Cucurbita moschata, Cichorium endivia, Lactuca sativa and Taraxacum officinale were found susceptible.

Results suggest that the yellowing disease affecting melon crops in the southeast of Spain is due to a pathogen similar to beet pseudo yellows virus, but this has to be confirmed by serology.

STALLKNECHT, G.F., J.E. DUFFUS, and J. SCHAEFFER. Curly top virus in grain Amaranth. Proceedings Fourth National Amaranth Symposium, Minneapolis, MN, Aug. 23-25, 1990.

The curly top virus disease has caused severe and widespread losses to sugarbeets and numerous vegetable crops. The virus was first reported in 1888. The virus is transmitted only by a single insect, the beet leafhopper, Circulifer tenellus. The virus has a wide host range which includes 44 plant families and 300 species. The virus appears to be more severe in arid and semi arid areas,and has a wide distribution on desert and weed plants, particularly Russian Thistle and Mustards in the Western U.S. The virus exists as a complex of strains, which can vary in virulence and host ranges. The principle method of control is the breeding of plants having resistance to the virus. Control of the leafhopper is quite difficult since the vector can be wind carried over several hundred miles, and can produce several generations of offspring yearly. However insecticide spray programs are presently being used in several western sugarbeet growing areas.

In 1989, a serious outbreak of curly top virus occurred (for the first time in the history of beet production 80 + years) in the Western sugarbeet Billings factory area. This area extened from west of Billings Mt. eastward 100 miles to approximately Forsyth Mt. Sugarbeets are grown on approximately 30,000 acres along the Yellowstone river valley.

The curly top virus was particularly severe in fields planted to sugarbeet varieties which had moderate or no resistance to the virus disease. In surveys the sugarbeet fields we noted that many of the Red Root Pigweed species (Amaranthus retroflexus)

exhibited the stunted, wilted and yellowing symptoms similar to the sugarbeet plants. At approximately the same time we noted similar symptoms in the grain Amaranth plants grown at the Southern Research Center. Plant samples of sugarbeets, Red Root Pigweed, and grain Amaranth species which exhibited symptoms were sent to the Salinas laboratory for evaluation. All plants tested positive for the curly top disease.

Grain Amaranth plants which were inoculated with either the two mild strains or one severe strain of curly top virus significantly reduce seed yields. Plant height was also reduced by the virus,inoculated plants heights ranged from 12 - 18 cm as compared to 100 - 120 cm for the untreated controls. No significant differences in either seed yield or plant height were noted among the three curly top virus strains.

The results of curly top virus disease on grain Amaranth observed at Huntley Montana in 1989, suggest that grain Amaranth production should not be considered in areas having the curly top virus. It is possible that the severe infestation of viruliferous leafhoppers could have been in part due to the fact that large acreages were planted to grasses in the crop reserve program in 1989, and that these fields had high population of Russian Thistle (<u>Salsola</u> <u>kali</u>) which is an excellent host for the beet leafhopper. Scouting observations in sugarbeet fields and in research grain Amaranth plots at Huntley in 1990 indicate that the virus is present in the crops, however the incidence of the disease appears to be significantly lower. Our results indicate that the curly top virus has the potential to be an important plant disease of grain Amaranth since it severely reduces seed production.

YU, M.H. <u>Chromosome complements of sugarbeet plants induced from unpollinated ovules</u>. Proc. 8th Intl. Cong. Human Genet. p. 280. 1991.

Ovule culture has the potential to identify and isolate more rapidly and accurately superior genotypes, thus accelerating sugarbeet breeding procedures. Plants were obtained by in vitro culture of unpollinated ovules from diploid sugarbeet. Thederivative plants generally were smaller in size and less vigourous in greenhouse culture than comparable seed-grown sugarbeet. Chromosome numbers ranged from 9, 18, 36, 9/18, 18/36 to 9/18/36 based on root tip chromosome counts of 141 plants. Sixty-nine plants with 18 chromosomes were classified as diploids and 10 were haploids having 9 chromosomes. Even though spontaneous endopolyploidization occurs in root meristems more frequently than in shoot apices in sugarbeet, the occurrence of over 40% doubled haploid plants is a significant

event. If such rates for chromosome doubling are substantiated by subsequent seed production, then for future sugarbeet research mediated by ovule culture, artificial chromosome doubling could be omitted. If donor plants are hybrids or heterozygotes, a rapid recovery of homozygosity and creation of diversity for sugarbeet genotypes could result.

YU, M.H. Susceptibility levels of beet germplasm and the infection of root-knot nematode. Agron. Abstr. p. 122. 1991.

The root-knot nematode (Meloidogyne spp.) is a destructive pest of sugarbeet (Beta vulgaris L.); search for resistance to the nematode thus becomes important. Studies were conducted in the growth chamber and greenhouse. The second stage juveniles (J2) penetrated into beet roots which induced giant cells and formed stainable galls in six days, and started to show dimorphic traits in eight days. Nematode developed rapidly in plant tissue and exuded egg matrices within 28 days. A wide variety of Beta germplasm from different sources were screened through J2 inoculations. Most lines that were tested were highly susceptible. Even though variation on the levels of susceptibility among lines was broad, genotypes with high levels of resistance to root-knot nematode are yet to be identified.

YU, M.H., and L.M. PAKISH. Association of a nematode resistance bearing addition chromosome with a recurring leaf intumescence somaclonal variation in sugar beet. Genome, 34: 477-485. 1991.

Intumescent leaf variants of sugar beet (*Beta vulgaris* L.) were obtained through callus culture of a monosomic addition that carried resistance to *Heterodera schachtii* Schm. The frothy pockmarked appearance of the leaf surface was due to hyperplastic growth of the mesophyll and epidermal cells. The epidermis had many malformed stomata. Veins were under-developed, but protrusions beneath were pronounced. Intumescence occurred in 20.3% of the regenerated plants and it was heritable to F_1 and later progeny. Leaf intumescence is a new phenotype for *Beta*. About 73.5% of regenerants contained the donor somatic chromosome number, the remainder were doubled or mixoploids, with no chromosome losses apparent. The 38-chromosome intumescent plant represents a dual somaclonal variation, chromosome doubling and leaf intumescence. Progeny of the 19- and 38-chromosome intumescent plants intercrossed or pollinated by diploids or tetraploids had 9, 18, 19, 27, 28, 29, 36, 37, 38, or 39 chromosomes. All intumescent plants were aneuploids with the monosome addition. There were linkages for leaf intumescence (*Li*), resistance to *H.schachtii* (*Hs*), and hypocotyl color (R^{pro}) on the addition

chromosome. The efficacy of *Hs* remained intactthrough the in vitro culture and succeeding crosses. The *Li*-bearing plants manifested depressed growth and markedly reduced seed set. Leaf intumescence was thought to be the alternative expression of galling potential of *Beta procumbens* Chr. Sm. germ plasm.

Papers Published Since Abstracted in Previous Report

HASSAN, A.H., and J.E. DUFFUS. A review of a yellowing and stunting disorder of curcubits in the United Arab Emirites. Emir. J. Agric. Sci. 2:1-16. 1991.

LEWELLEN, R.T. Use of plant introductions to improve populations and hybrids of sugarbeet. In Shands, H.L., and L.E. Weisner (eds). Use of Plant Introductions in Cultivar Development, Part 2, CSSA Special Publication no. 20. p. 117-136. 1992.

LEWELLEN, R.T. Registration of rhizomania-resistant germplasm of *Beta vulgaris*. Crop Sci. 37:244-245. 1991.

DEVELOPMENT OF SUGARBEET BREEDING LINES AND GERMPLASM

R.T. Lewellen

BREEDING LINES C31-43 AND C31-89 - In 1991, breeding lines C31-43 and C31-89 were officially released. This germplasm represented ongoing efforts to combine multiple disease resistance with high productivity and to enhance source populations for commercial breeders. These lines are multigerm and self-sterile and were selected from C31/6 for improved performance under BYV infected conditions. These lines were extensively tested in 1990 (see 1990 Report). Because of low seed inventory, they were less extensively tested in 1991. As lines per se in nondiseased Test 691, they had superior performance to C31/6 for both % sugar and sugar yield and were among the highest yielding entries which included several commercial hybrids. Under BYV infected conditions (Test 1591) they were the two superior lines. They had significantly higher sugar yield than nearly all of the other entries. Based upon Test 2091, they are resistant to Erwinia with an intermediate reaction to powdery mildew. They have good bolting resistance but are moderately susceptible to curly top. In an ongoing program, they are being used as recurrent parents for a conversion to rhizomania resistance.

PERFORMANCE OF POLISH ACCESSIONS - In 1988, nine diploid sugarbeet accessions were received from Dr. Adam Szreder, Plant Breeding Station, Chodow, Poland. These lines coded P1 through P9 were of interest because of their putative high sucrose concentration. In 1989, a preliminary test of these lines was run and P1, P2, P3, P4, and P7 were increased for further evaluation. In addition, a composite of lines P1 through P7 was made. Experimental hybrids were produced with the composite, P2, and P4. In 1991, these increases and hybrids were tested at Salinas and Brawley. The increases of P1 through P7 were renumbered as Z011 through Z017, respectively, with the composite numbered as Z010. In Test 691 whereas a typical Salinas line had about 16% sugar, these Polish lines ranged from 17.35 to 18.94% sugar. However, their root yields and sugar yields were significantly less than most Salinas lines. As expected, these Polish lines were relatively susceptible to BYV (Test 1591). The experimental hybrids with the composite, P2, and P4 (see summary tables for tests throughout this 1991 Report) were generally lower in yield than the commercial hybrid checks and the level of sucrose concentration was intermediate between that expressed by the line and typical Salinas hybrids. These results do suggest that this Polish germplasm can be exploited as a source of high sucrose to make improvements in Salinas material. Toward this end, the composite, P2, and P4 were crossed to 9912. Popn-912 is a source of resistance to rhizomania, virus yellows, curly top, bolting, etc. Based upon the performance of these initial population hybrids (Tests 691, 1591, 2491, RZM 591, & RZM 3291), it appears very promising that these Polish lines will be useful as sources of sugar genes to improve disease resistant germplasm.

RESISTANCE TO CYST NEMATODE - Line B883 from the Netherlands is being used as a source of resistance to cyst nematode. As of 1991, three or four new homozygous, nematode resistant F_3 lines have been identified. These lines have the general appearance and growth characteristics of B883 but are slightly more vigorous. Their F_1 nematode resistant hybrids, however, appear to be nearly normal in appearance. At this time, they are being used in the Salinas program as bridges to continue backcrossing nematode resistance into rhizomania and disease resistant backgrounds. Except from the homozygous resistant sources, the transmission rate remains very low. Thus, resistance from this source will probably have to be stabilized and deployed with homozygous resistant parental lines. A question remains as to whether even the F_1 hybrids with heterozygous but homogeneous resistance will be useable because of the very poor performance, particularly for % sucrose, of B883 extractions. It is not clear whether this poor performance is due to linkage with deleterious factors from *Beta procumbens* or to the background of B883 independent of nematode resistance. In an attempt to transmit and breed nematode resistance on a population basis, breeding lines such as N911, N012, N941, N042, N971, and N072 were developed. It is now known that the level of nematode resistance in these F_2 and BC_1F_2 populations is extremely low and therefore probably also is any contribution from *B. procumbens* or other factors linked with nematode resistance. The performance of these lines relative to their respective recurrent parents (R78, popn-911, & popn-867) then, should give some insight into the relative background performance of B883. Results of 1990 (RZM 190-4, RZM 3490, RZM 190-5, RZM 290-2) and 1991 (691, 2491, RZM 591) tests suggested that a significant portion of the poor performance of derivities and hybrids involving B883 is due to factors not specifically associated with its nematode resistance. This evidence provides hope that nearly normally performing, nematode resistant hybrids can be developed.

S_1 PROGENY RECURRENT SELECTION - In the early 1970s, a monogerm self-fertile, O-type population that segregates for genetic male sterility was developed and identified as popn-790. Since 1977, five cycles of S_1 progeny recurrent selection have been completed. Test 791 summarizes the comparison in performance of cycles 0, 4, and 5. Based upon the results of this test, a 29% increase in population sugar yield occurred over five cycles of selection. Improvements occurred for both root yield and % sucrose. Near significant differences between cycle 4 and 5 for sugar and root yield and % sucrose showed that further improvements should be possible.

PERFORMANCE OF S_1 LINES FROM POPN-790 (C4) - In 1989, 100 S_1 lines derived from the fifth cycle of S_1 progeny recurrent selection within popn-790 were progeny tested at Brawley, under LIYV conditions (see page A68, 1989 Report) and at Salinas under BYV inoculated and November planted bolting conditions (see pages A22-A23, 1989 Report). Based upon these S_1 per se tests, eight S_1 lines were selected and genetic male sterile plants topcrossed to line R80. In 1991, these topcross hybrids were evaluated in tests at Brawley (B591) and Salinas under nondiseased (591) and BYV infected (1391) conditions. In these tests, three lines

consistently had high performance for sugar yield. These lines, 8790-6, 8790-15, and 8790-54 are targeted for release in 1992 as C790-6, C790-15, and C790-54. In the 1991 tests, there were usually four topcross hybrids above and four below the performance of the source population hybrid. These results suggested that the S_1 progeny per se tests were successful at identifying performance for disease resistance, adaptation, and % sucrose, but did not predict the hybrid performance of these progenies. In the 1991 hybrid tests, lines 8790-6, -15, and -54 consistently had better hybrid performance than C790-68. C790-68 was one of the superior lines extracted from popn-790 (C2). This suggested that the additional cycles of S_1 progeny recurrent selection had sufficiently improved the base performance of this population so that higher performing lines could be identified and isolated.

OPEN-POLLINATED COMMERCIAL CULTIVARS ? - Until about 1960, open-pollinated cultivars were used in California. One of the last O.P. varieties used in California was US75. US75 or actually increases of it, is still used as a check in our tests. Assuming that the present version of US75 is not substantially different in performance from the former commercial seed lots, large improvements in yield have been achieved in open-pollinated lines. For example, in Test 691, US75 was only about 75% of the yield of breeding lines such as C31-43, C49, and many others. This difference is even greater in comparisons under diseased conditions. In tests 1491 and 1591 under BYV infected conditions, US75 performs only at about 50% of the level of the best O.P. lines. These large improvements in performance show that our long term breeding project has made significant advances, however, it also raises a different question - how do these new O.P. lines compare to commercial hybrids in performance? Frequently, in our California trials in which there is a mix of hybrids and advanced O.P. breeding lines, the best performance is by an O.P. line. For example, in Test 691, the several commercial hybrid checks were only as good as the best O.P. lines. Under diseased conditions, it is usual that the disease resistant lines perform better than the hybrids. In disease prone areas of California, is it possible that the industry would be better off using monogerm, open-pollinated, commercial cultivars? With the potential threat of a smaller industry, particularly in some areas, should breeders be seriously looking at monogerm, O.P. cultivars that are easier and less expensive to develop and that would reduce the interval of time for improvements in productivity, quality, and improved disease resistance?

RHIZOMANIA RESISTANCE FROM PI206407 - Line C28 was released several years ago as a source of resistance to rhizomania. Tests of inheritance and allelism have not been conclusive, but suggested that the resistance from PI206407 (PI07) is inherited as a simple dominant factor and is not alletic to $\underline{R}_{\underline{z}}$ (Holly gene). Near-isogenic lines are being developed to evaluate the level of protection provided against rhizomania by these sources. Differential performance for sugar yield obtained in Test 691 under nondiseased conditions and Test 2491 under rhizomania conditions suggested that they are different and that the PI07 factor may provide a higher level of protection.

Comparison of R_Z and PI206407 Sources of Resistance

Variety	Description	Sugar Yield (lbs/a) Non-Rhizom.[1]	Rhizomania[2]
U86-37	C37	17,240	4,950
R079	C37R_Z	16,450	6,440
R028	C37 x (C37 x PI07)	14,550	7,160
R030	C37R_Z x (C37 x PI07)	16,470	7,020
5747	747	----	5,470
0910	747R_Z	17,940	6,700
R029	747 x (747 x PI07)	17,020	7,710
R030	747R_Z x (747 x PI07)	17,020	7,710
LSD (.05)		2,018	840

[1]Test 691. [2]Test 2491.

The contribution to performance and modifying or background factors for resistance to rhizomania contributed by PI07 may still be important because R028 and R029 represented only the first backcross. Most likely, however, the chard-like plant from PI07 would have had a negative effect on yield as in Test 691, rather than a positive one. Under moderate rhizomania conditions in Test 2491, R028 and R029 were nearly significantly higher yielding than their corresponding R_Z line counterpart. Although preliminary inheritance data and these performance data suggest different genetic factors, this relationship needs to be investigated further.

GENETIC VARIABILITY FROM BETA MARITIMA - *B. maritima* is now known to be a source of resistance to rhizomania, cercospora leaf spot, etc. At Salinas, populations between sugarbeet x *B. maritima* have been developed, selected and evaluated for reaction to specific diseases, and tested for yield performance. Breeding lines with *B. maritima* as part of their germplasm base were included in many trials in 1991, but Tests 691-2, 1191, 2491-4, and RZM 291 focused on the performance of these materials under both nondiseased and diseased conditions. Tests under rhizomania conditions (Test 2491-4 and RZM 291) continued to show that high levels of resistance occur within these lines. Under BYV infected conditions (Tests 1191, 1491, 1591) after just one cycle of selection, line R022Y1 (50% *B. maritima* accessions) was within 85% of the sugar yield of the sugarbeet checks. Under powdery mildew conditions (Test 2491-4), breeding lines EDW-6,7 and EDW-8,9 with germplasm from WB97 and WB242 had a high frequency of plants that segregated for immunity to *Erysiphe*. Also in Test 2491-4, under moderate rhizomania conditions, breeding lines with WB258 and WB151 showed higher % sugar than rhizomania resistant sugarbeet breeding lines R080 and C39R, suggesting that *B. maritima* may also be a source of genes for sucrose content. In Test 691-2 under nondiseased conditions, R022Y1 (50% *B. maritima*) had 61 tons per acre at 15% sugar. The impression from these tests is that sugarbeet and *B. maritima* may not be as genetically different as generally thought and that it may be possible to relatively quickly transgress new genetic variability into the sugarbeet base from this wild germplasm.

VARIETY TRIALS, SALINAS, CALIFORNIA, 1991

U.S. Agricultural Research Station, Spence Field

Tests were located in Block 2, south half (10 acres). A series of three plantings were made. Following fall preparation, plot area was limed, prefertilized and listed, and then shaped just prior to planting. Nortron-Pyramin was used on all plantings. Emergence was obtained with sprinkler irrigation. Sprinkler irrigation was primarily used as needed through the season, but some tests were also furrow irrigated part of the time. Ammonium sulfate and irrigation applied soluble nitrogen were applied as needed. Even though soil tests showed the area to be infested with rhizomania, essentially no rhizomania was evident in the plants. Metasystox-R was applied to control green peach and black bean aphids. The tests in this planting showed no stress through the course of the 8 to 9 month season. Sugar yields were very high in all types of breeding material.

Yield Trials - Tests 191 through 1091 were planted January 25, 1991. The primary purpose was to evaluate breeding materials for yield under non-diseased condition. These tests were very uniform and showed very high productivity. Powdery mildew was controlled until late summer with Bayleton. Beet western yellows virus was evident on most plants in susceptible cultivars. Downey mildew occurred in late spring.

Beet Yellows Trials - Tests 1191 through 1691 were planted February 12, 1991. They were partially inoculated with BYV on May 10, 1991. The primary purpose was to measure differential effects of BYV on yield and to evaluate BYV resistance. Powdery mildew was not controlled and became moderately severe on susceptible entries.

Powdery Mildew/Erwinia Root Rot Trials - Tests 1791 through 2191 were planted April 16, 1991. They were to evaluate breeding material for reaction to powdery mildew and/or Erwinia root rot. Powdery mildew was from natural infection. Plots were inoculated with Erwinia on July 11, 1991. The level of root rot was higher and more uniform than obtained in recent tests at Salinas.

PROGENY TESTS - In 1991, three sets of half-sib progenies from three populations were evaluated at Brawley and Salinas. The populations were R80, 913, and 864. Line R80 is similar to C54 and is multigerm, self-sterile, and segregates for resistance to rhizomania (R_z). Popn-913 is multigerm and segregates for self-fertility and R_z. The progenies actually involved genetic male sterile plants of popn-911, popn-913, and popn-903 outcrossed to fertile plants of popn-911 and popn-913. Popn-864 is monogerm, self-fertile, and segregates for R_z. For R80 and 913, 96 progenies were evaluated in four replications in each test. For 864, 40 families were evaluated at Salinas under nondiseased and rhizomania conditions. Progenies of popn-913 were evaluated at Brawley and at Salinas under BYV infected conditions and for *Erwinia* and powdery mildew. For Line R80, progenies were evaluated at Salinas under nondiseased, BYV, rhizomania, *Erwinia* and powdery mildew conditions. In Test 891 at Salinas under nondiseased conditions and a 9 month growing season, the mean root (62.6 t/a) and sugar (19,940 lbs/a) yields were the highest ever achieved in one of my yield tests. The harvester was "maxed-out" and the sugar lab crew complained. These yields demonstrated the yield potential and capacity of sugarbeet when very few constraints are placed upon their growth.

TEST 1691. Means and Ranges for Line R80 at Salinas under BYV Infection

96 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: February 12, 1991
Harvested: October 24, 1991

Variable	Mean	Range	LSD (.05)	C.V. (%)
Sugar Yield (lbs/a)	11,240	8,920 - 13,030	1,530	9.8
Root Yield (t/a)	36.4	28.8 - 43.3	4.6	9.2
% Sucrose	15.4	14.6 - 16.5	0.7	3.1
Beets/100 ft.	137	93 - 153	13.5	7.1
RJAP	83.1	79.4 - 85.6	2.3	1.9
Powdery Mildew	6.7	4.7 - 8.4	0.9	10.0
Virus Yellows Score	4.3	3.3 - 5.4	0.6	10.5

TEST 1891. Evaluation for Erwinia and Powdery Mildew for R80

96 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: April 16, 1991
E.c.b. Inoc: July 11, 1991
Scored: October 3, 1991

Erwinia (DI)[1]	9.0	0.0 - 35.9	---	---
Erwinia (% Resist.)	82.3	50 - 100	---	---
Powdery Mildew	5.2	2.8 - 7.0	---	---
% Downey Mildew	6.8	0.0 - 38.1	---	---

[1]DI for checks (8 reps): US H11 = 8.2; C40 = 65.2.

TEST 891. Means and Ranges for Line R80 at Salinas under Nondiseased Conditions

96 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: October 26, 1991

Variable	Mean	Range	LSD (.05)	C.V.(%)
Sugar Yield (lbs/a)	19,940	16,580 - 23,360	2,590	9.3
Root Yield (t/a)	62.6	53.4 - 72.4	7.7	8.9
% Sucrose	15.9	15.3 - 16.7	0.7	3.0
% Bolting	0.9	0.0 - 8.2	2.5	191
Beets/100 ft.	141	121 - 157	13.3	6.7
RJAP	84.2	82.4 - 86.1	2.2	1.8
Powdery Mildew	3.9	1.4 - 6.6	1.5	27.2

TEST 2591. Means and Ranges for Line R80 at Salinas under Rhizomania Conditions

96 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: May 8, 1991
Harvested: November 12, 1991

Variable	Mean	Range	LSD (.05)	C.V.(%)
Sugar Yield (lbs/a)	6,971	4,940 - 8,500	1,600	16.5
Root Yield (t/a)	23.0	16.6 - 28.6	5.5	17.2
% Sucrose	15.2	14.2 - 16.1	0.9	4.3
Beets/100 ft.	158	89 - 200	27.9	12.7
RJAP	82.3	79.7 - 84.4	3.3	2.9
Powdery Mildew	5.5	3.4 - 7.5	1.3	16.5

TEST B491. Means and Ranges for MM,S^f,A:aa Popn-913 at Brawley

96 entries x 4 reps, RCB
1-row plots, 10.5 ft. long

Planted: September 27, 1990
Harvested: May 17, 1991

Variable	Mean	Range	LSD (.05)	C.V.(%)
Sugar Yield (lbs/a)	9,900	8,530 - 11,920	1,570	11.4
Root Yield (t/a)	34.0	28.2 - 40.5	5.3	11.1
% Sucrose	14.6	13.3 - 16.6	1.0	5.1
% Bolting	6.0	0.0 - 51.9	9.4	113
Beets/100 ft.	121	96.2 - 140.6	25.0	15
% Roots with Phoma	8.1	0.0 - 52.5	9.3	82
% Clean Roots	93.3	87.3 - 96.7	3.9	3.0

TEST 991. Means and Ranges for MM,S^f,A:aa Popn-913 at Salinas under BYV Infection

96 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: October 22, 1991

Variable	Mean	Range	LSD (.05)	C.V.(%)
Sugar Yield (lbs/a)	13,720	10,780 - 17,020	1,890	9.9
Root Yield (t/a)	45.1	35.1 - 53.4	5.8	9.3
% Sucrose	15.2	13.6 - 16.3	0.8	3.6
% Bolting	0.1	0.0 - 3.2	1.2	655
Beets/100 ft.	145	127 - 159	13.0	6.5
RJAP	82.1	78.8 - 85.6	2.2	2.0
Powdery Mildew	4.5	1.5 - 7.4	1.2	19.1
Virus Yellows Score	5.1	3.7 - 6.9	0.9	12.9

TEST 1991. Evaluation for Erwinia and Powdery Mildew for Popn-913

96 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: April 16, 1991
E.c.b. Inoc: July 11, 1991
Scored: October 4, 1991

Erwinia (DI)[1]	9.8	0.0 - 46.2	---	---
Erwinia (% Resist.)	79.2	40 - 100	---	---
Powdery Mildew	4.6	2.0 - 7.0	---	---
% Downey Mildew	6.2	0.0 - 56.0	---	---

[1]DI for checks (8 reps): US H11 = 8.2; C40 = 75.1.

TEST 1091. Means and Ranges for mm,S^f,A:aa Popn-864 at Salinas

40 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: September 13, 1991

Variable	Mean	Range	LSD (.05)	C.V. (%)
Sugar Yield (lbs/a)	13,020	10,780 - 14,310	1,780	9.8
Root Yield (t/a)	44.8	34.5 - 50.6	5.8	9.2
% Sucrose	14.5	13.6 - 15.6	0.7	3.7
% Bolting	1.8	0.0 - 14.1	3.2	129
Beets/100 ft.	145	127 - 154	12.9	6.4
RJAP	82.1	80.3 - 83.8	2.0	1.7
Powdery Mildew	5.5	4.5 - 7.8	1.2	15.3

TEST 2891. Means and Ranges for mm,S^f,A:aa Popn-864 at Salinas under Rhizomania

40 entries x 4 reps, RCB
1-row plots, 18 ft. long

Planted: May 8, 1991
Harvested: November 8, 1991

Variable	Mean	Range	LSD (.05)	C.V. (%)
Sugar Yield (lbs/a)	4,430	3,080 - 5,890	1,375	22.2
Root Yield (t/a)	16.0	11.5 - 20.5	5.0	22.3
% Sucrose	14.0	12.9 - 15.3	1.0	4.9
Beets/100 ft.	155	111 - 197	45.0	20.2
RJAP	78.2	74.8 - 81.4	3.2	2.9
Powdery Mildew	6.1	4.9 - 7.3	1.0	11.7

TEST 691-1.[1] YIELD EVALUATION OF MULTIGERM, O.P. GERMPLASM LINES, SALINAS, CA., 1991

16 entries x 6 replications, RCB
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: October 7-9, 1991

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score Avg	RJAP %
768	Inc. 868 (US 75)	15190	50.84	14.94	1.2	0.0	146	5.6	84.1
U86-37	Inc. C37 (86443)	17240	53.43	16.13	0.0	0.0	149	6.8	85.6
R079	RZM R979 ($C37R_z$)	16450	52.99	15.55	7.7	0.0	150	5.3	84.7
R028	RZM 9221 (C28)[z]	14550	49.00	14.88	14.3	0.0	147	6.0	84.5
R030	RZM 9225 ($C37R_z$xC28)	16470	54.54	15.13	13.0	0.7	146	2.9	84.0
U86-46/2	Inc. C46/2 (86342)	17780	53.50	16.66	0.0	0.0	145	2.6	85.6
R078	RZM R978C2 ($C46R_z$)	18640	59.05	15.82	1.2	3.4	156	2.8	86.0
Y931-43	Inc. Y731-43 (C31-43)	20240	61.65	16.43	0.0	0.7	143	3.1	84.7
Y931-89	Inc. Y731-89 (C31-89)	19030	57.67	16.51	0.6	0.0	146	2.7	84.8
F86-31/6	Inc. C31/6 (86263)	18420	58.60	15.70	0.6	2.0	152	3.0	84.2
R076	RZM R976 ($C31R_z$)	17570	58.60	14.94	8.8	1.3	147	4.4	83.9
R070	Inc. R971-R980[z]	17440	56.09	15.53	0.0	0.0	144	4.3	84.6
Rhizosen	Holly (L493302)	19660	62.58	15.71	0.0	1.3	144	5.8	87.1
Y048	Inc.Y948(C93)	17500	51.43	17.00	0.6	0.0	147	3.5	83.7
Y049	BYR-ER-PMR Y849 (C49)	20310	61.48	16.52	1.9	0.0	148	1.2	84.4
Y057	BYR-ER-PMR Y857	19160	57.79	16.56	0.6	0.0	145	3.8	83.8
Mean		17853	56.20	15.87	3.16	0.59	147.2	3.99	84.72
LSD (.05)		2019	5.40	0.80	3.76	2.04	8.9	1.09	2.63
C.V. (%)		9.83	8.35	4.39	103.42	302.73	5.3	23.72	2.69
F value		5.41**	4.61**	5.88**	13.41**	1.84*	1.1NS	16.36**	0.97NS

[1] TEST 691. YIELD EVALUATION OF GERMPLASM LINES AND POPULATIONS
80 entries x 8 replications, Incomplete blocks with 5 subsets each with 16 varieties x 8 reps, RCB
Thus, means across tests 691-1,-2,-3,-4,-5 can be compared.

	Sugar Lbs	Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score Avg	RJAP %
Mean	17486	54.99	15.92	5.27	0.06	146.8	4.15	84.29
LSD (.05)	2018	5.84	0.81	4.67	2.18	10.35	1.26	2.67
C.V. (%)	10.17	9.35	4.46	78.19	321.18	6.21	26.66	2.79
F value	7.07**	7.41**	11.07**	37.30**	1.63**	1.68**	10.16**	1.76**

TEST 691-2. YIELD EVALUATION OF MULTIGERM, O.P. GERMPLASM LINES AND, SALINAS, CA., 1991

(continued)

Variety[2]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	PM Score Avg	RJAP %
Y054- 2	Inc. Y854- 2	19510	62.37	15.65	0.0	0.0	142	1.9	85.5
Y054-12	Inc. Y854-12	18080	56.53	15.97	3.3	0.0	142	3.3	85.0
Y054-23	Inc. Y854-23	19000	60.38	15.71	0.6	0.0	146	2.6	83.5
Y054-38	Inc. Y854-38	19020	60.52	15.72	0.0	0.7	151	1.9	82.8
Y054-63	Inc. Y854-63	17330	53.58	16.19	0.0	0.0	148	3.4	81.5
Y054-85	Inc. Y854-85	17880	55.06	16.24	0.0	0.0	152	3.1	84.8
Y054	BYR-ER-PMR Y854 (C54)	18570	56.84	16.36	0.7	0.0	150	1.7	85.2
R980	RZM 8244-# ($C54R_z$)	19270	61.19	15.72	0.0	0.0	151	3.7	83.3
R080	Inc. R980 ($C54R_z$)	19000	58.97	16.14	1.4	0.0	134	3.9	84.9
R080	RZM R980 ($C54R_z$)	19250	62.15	15.49	0.6	0.0	151	4.4	84.0
Y54 x B.maritima									
Y954	Inc. Y854	18030	56.09	16.09	0.0	0.6	151	2.4	84.0
R722	Inc.F_2(Y54xB.m.)(C50)	13330	44.41	14.98	39.5	0.7	152	4.7	82.0
R922Y1	BYVR R722	17400	56.39	15.47	8.1	0.0	149	4.1	82.8
R022Y1	Inc. R922Y, R922S	18330	60.89	15.05	2.5	1.2	152	4.2	82.9
R922R1	RZM R722	15060	51.43	14.70	29.6	0.0	153	5.3	82.4
R022R2	RZM R922R	16240	56.09	14.46	22.4	1.8	149	5.3	81.3
Mean		17831	57.06	15.62	6.80	0.31	148.3	3.49	83.49
LSD (.05)		2155	6.53	0.77	4.42	1.12	8.8	1.33	2.46
C.V. (%)		10.51	9.96	4.27	56.59	314.75	5.2	33.16	2.56
F value		4.88**	4.00**	4.39**	61.78**	1.86*	2.6**	6.04**	2.39**

[2]Y054-#'s = half-sib progenies from Y854. R722 = C50 = Y54 x B.maritima accessions.
R922R1 and R022R2 = cycle 1 and 2 of selection for resistance to rhizomania from R722.
R022Y = cycle 1 of mother root selection for BYV resistance.

TEST 691-3. YIELD EVALUATION OF MULTIGERM, O.P. GERMPLASM LINES, SALINAS, CA., 1991

(continued)

Variety[2]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score Avg	RJAP %
R047C6	RZM R947C5 (C47R6)	18480	57.94	15.96	0.6	1.1	159	5.9	85.1
R047C5	Inc. R947C5 (C47R5)	18280	58.60	15.63	9.3	0.0	149	5.5	85.7
Y047	Inc. Y947 (C47)	18490	57.61	16.07	1.9	1.9	146	3.0	84.8
Y039	Inc. Y939 (C39)	16380	48.88	16.76	2.8	0.0	134	1.5	85.6
R039C5	Inc. R939C5 (C39R6)	18210	57.69	15.74	9.9	0.7	140	1.8	84.6
R039C6	RZM R939C5 (C39R5)	18790	59.49	15.77	3.2	0.0	151	1.7	83.7
Z012H12	9912aa x Polish C	20000	58.90	16.96	1.8	0.0	152	5.3	85.3
Z012H12	9912aa x Polish 2	19280	57.12	16.90	3.1	1.2	152	4.7	84.6
Z014H12	9912aa x Polish 4	19230	57.96	16.59	0.0	0.8	137	3.9	84.5
6625	Beta 6625 (0011-1)	20420	58.97	17.30	0.8	0.6	150	3.9	86.8
Z010	Inc. Polish C	15790	43.52	18.19	2.0	0.0	140	5.1	84.6
Z011	Inc. Polish 1	17020	45.01	18.94	10.3	0.7	139	5.1	84.6
Z012	Inc. Polish 2	17880	51.35	17.41	2.6	2.6	140	3.8	80.9
Z013	Inc. Polish 3	15750	43.23	18.23	2.4	2.5	151	5.2	82.8
Z014	Inc. Polish 4	15820	42.34	18.71	2.3	1.9	150	4.3	84.7
Z017	Inc. Polish 7	16760	48.40	17.35	8.9	2.0	144	5.7	85.6
Mean		17912	52.94	17.03	3.87	1.00	145.9	4.15	84.62
LSD (.05)		1885	5.42	0.78	3.70	2.65	10.7	1.27	3.30
C.V. (%)		9.15	8.90	4.00	83.26	230.71	6.4	26.62	3.39
F value		5.05**	11.84**	14.76**	7.30**	0.98NS	3.4**	10.42**	1.30NS

[2]9912 = MM, S^f, A:aa, R_z population. Z010 = increase of composite of Polish-2n accessions 1 thru 7. Z011 thru Z017 = increase of individual Polish accessions.

TEST 691-4. YIELD EVALUATION OF MULTIGERM, S^f, A:aa POPULATIONS, SALINAS, CA., 1991

(continued)

Variety[2]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	PM Score Avg	RJAP %
9910	8910aa x A	18220	58.68	15.54	0.7	0.0	145	6.2	84.6
0910	RZM 9910H47 (A,aa)	17940	59.06	15.14	0.6	0.0	146	5.3	84.0
N042	NR-RZM 9205,7,8	15530	51.88	14.95	0.0	0.6	149	6.3	84.0
R029	RZM 9223	17020	57.12	14.90	16.8	0.0	152	4.8	84.1
R031	RZM 9226	17020	57.27	14.84	29.5	0.0	151	5.3	84.1
8909	7909aa x A	20140	63.18	15.93	2.5	0.0	149	4.3	84.5
0911	RZM 9911 (A,aa)	18920	59.27	15.96	0.0	0.6	152	3.6	83.7
0911	9911aa x 9911H49	19380	62.22	15.56	0.6	0.0	148	5.3	83.8
0913	9911H49aa x 9911H49	18280	58.23	15.70	1.3	0.6	150	3.9	83.4
0913	RZM 9911H49 (A,aa)	18800	59.56	15.76	0.0	0.0	147	3.2	82.9
0915	9903aa x 9911H49	19190	61.95	15.47	0.6	1.9	151	4.8	84.1
9912	RZM 8908,...,11aa x A	19880	61.48	16.22	4.8	0.6	153	5.6	87.5
0914	RZM R939/4H44 (A,aa)	17140	53.43	16.06	1.9	0.7	149	1.3	85.6
R020	Inc. R920 (C94)	15260	53.13	14.30	24.2	0.0	142	4.9	83.1
R020	RZM R920 (C94)	15740	54.32	14.52	14.0	0.6	151	2.8	84.0
R004	RZM R904 (Rovigo Acc.)	10430	41.83	12.51	66.2	6.6	143	4.9	84.0
Mean		17430	57.04	15.21	10.23	0.77	148.6	4.53	84.21
LSD (.05)		2321	6.65	0.89	7.27	3.16	6.7	1.29	2.69
C.V. (%)		11.58	10.14	5.09	61.80	358.57	3.9	24.66	2.78
F value		8.50**	5.05**	8.40**	46.82**	2.10*	2.0*	8.33**	1.22NS

[2]R020 = C94 = multigerm, self-sterile from Colorado germplasm sources.

TEST 691-5. YIELD EVALUATION OF GERMPLASM LINES AND POPULATIONS, SALINAS, CA., 1991

(continued)

Variety[2]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	PM Score Avg	RJAP %
0722	Inc. T-O 9722-#	12650	41.96	15.06	0.0	0.6	141	3.0	84.2
0755	BYR-ER-PMR 8755 (C310)	13510	42.94	15.75	0.6	0.6	146	3.5	87.0
0866	RZM 9866H80 (C310R_z)	16150	49.88	16.21	0.7	0.0	147	3.9	83.6
0865	RZM 9865 (C309R_z))	14090	43.82	16.08	0.0	0.7	145	6.4	81.2
0787	BYR-ER-PMR 8787	16880	53.73	15.75	0.0	0.0	148	4.8	86.2
0887	RZM 9887H86 (787R_z)	16600	53.87	15.42	1.3	0.0	143	5.6	83.6
0859	RZM R9859H6 (C563R_z)	15890	50.65	15.66	0.6	0.6	143	6.5	84.0
0864	9864aa x A	16790	53.13	15.81	4.0	0.6	146	4.6	84.9
0867	RZM 9867H67 (767R_z)	16540	52.69	15.69	1.3	0.6	150	4.4	84.1
0876	RZM 9876H76 (776R_z))	16200	51.69	15.66	0.0	0.0	144	5.1	83.9
Inc. popn-906,909 S_1 lines									
0906-4	Inc. 8906A-4 (A,aa)	16960	54.54	15.51	9.4	0.0	146	5.8	83.7
0906-7	Inc. 8906A-7 (A,aa)	16260	50.99	15.97	1.2	0.7	146	7.0	83.4
0909-7	Inc. 8909A-7 (A,aa)	19430	59.12	16.44	5.4	0.0	141	4.2	84.9
0909-34	Inc. 8909A-34 (A,aa)	19040	57.05	16.68	3.3	0.0	143	2.1	86.5
0909-37	Inc. 8909A-37 (A,aa)	20440	64.39	15.89	2.6	0.0	141	1.4	85.3
0909-48	Inc. 8909A-48 (A,aa)	14990	47.13	15.91	8.9	0.6	137	4.9	84.3
Mean		16402	51.72	15.84	2.45	0.32	144.0	4.57	84.42
LSD (.05)		1814	5.53	0.73	3.70	1.29	7.4	1.05	2.44
C.V. (%)		9.62	9.30	4.01	131.35	346.01	4.5	19.93	2.51
F value		10.18**	9.06**	2.27*	5.41**	0.54NS	1.6NS	17.49**	2.64**

[2] 0906-4 thru 0909-48 = increases of S_1 progenies from MM, S^f, A:aa, R_z populations.

TEST 791. EVALUATION OF C0 vs C4 vs C5 SYNTHETICS OF POPN-790 DEVELOPED BY S_1-PROGENY RECURRENT SELECTION, SALINAS, CA., 1991

4 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: October 7-9, 1991

Variety[1]	Description	Cycle[2]	Acre Yield: Sugar Actual lbs	Acre Yield: Sugar Change %	Acre Yield: Beets Actual tons	Acre Yield: Beets Change %	Sucrose Actual %	Sucrose Change % pts
7790C	7790Caa x A	C0, Syn 2	14950	0.0	54.43	0.0	13.76	0.0
8790L	7790Laa x A	C4, Syn 2	17970	20.2	60.80	11.7	14.78	1.0
0790	8790-S_1(C)aa x A	C5, Syn 1	19310	29.2	64.02	17.6	15.10	1.3
0790H124	9876mmaa x 8790-S_1	R_z,Syn 0	18850	--	62.94	--	14.99	---
Mean			17770		60.55		14.66	
LSD (.05)			1247		4.46		0.35	
C.V. (%)			6.75		7.08		2.32	
F value			21.41**		8.02**		26.01**	

[1] 7790C = source populationfrom 1977 (Syn 2 in 1987) developed by randomly mating a large number of unselected S_1 lines. 8790L = cycle 4 (synthesis 2) by S_1 progeny recurrent selection. 0790 = cycle 5 by S_1 progeny recurrent selection. 0790H124 = cross of selected S_1 lines to rhizomania (R_z) resistant source.

[2] C = cycle of S_1 progeny recurrent selection. Syn = generation of resynthesis throught genetic male sterile plants.

TEST 791. EVALUATION OF C0 vs C4 vs C5 SYNTHETICS OF POPN-790 DEVELOPED BY S_1-PROGENY RECURRENT SELECTION, SALINAS, CA., 1991

4 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: October 7-9, 1991

Variety	Bolters	Root Rot	Beets/ 100'	RJAP	Powdery Mildew
	%	%	No.	%	Avg.
7790C	1.8	0.0	155	83.35	6.8
8790L	0.0	0.0	156	83.54	6.3
0790	0.0	1.3	152	84.93	5.8
0790H124	0.0	0.0	149	84.60	6.8
Mean	0.44	0.32	153.25	84.11	6.44
LSD (.05)	1.93	1.33	5.87	1.99	0.63
C.V. (%)	418.92	396.81	3.68	2.27	9.40
F value	1.82NS	2.03NS	2.39NS	1.33NS	5.52**

TEST 191. HYBRID PERFORMANCE OF MULTIGERM GERMPLASM, SALINAS, CA., 1991

32 entries x 8 replications, RCB equalized
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: September 11-12, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Rating
Checks								
4757	Beta (1/6/89)	18560	58.39	15.89	0.8	0.0	159	1.2
HH41	Holly (L41138)	17370	56.15	15.47	0.4	0.0	161	5.5
6625	Beta 0011-1	17030	48.50	17.56	0.0	0.0	162	3.5
HH54	Holly (L543003)	15550	45.89	16.95	3.6	0.0	158	4.3
C309H3 x multigerms								
Y054H20	87-309H3 x BYR Y854 (C54)	17830	54.77	16.28	0.0	0.0	154	3.9
Y047H20	87-309H3 x Y947 (C47)	17780	55.05	16.15	0.8	0.5	157	5.0
Y039H20	87-309H3 x Y939 (C39)	17490	52.99	16.48	0.4	0.0	156	3.8
Y931SH20	87-309H3 x Y731S (C31/6)	17400	55.17	15.78	0.4	0.0	160	5.1
R047C5H20	87-309H3 x R947C5 (C47R5)	17140	53.71	15.95	0.5	0.0	156	5.4
R070H20	87-309H3 x R971-R980	17120	53.93	15.87	2.8	0.0	152	5.3
R039C5H20	87-309H3 x R939C5 (C39R5)	17080	54.21	15.76	1.8	0.0	151	3.4
Y846H20	87-309H3 x Y746 (C46/3)	17050	53.04	16.07	0.0	0.0	159	4.5
9912H20	87-309H3 x RZM 8909-11	17000	54.26	15.67	0.0	0.0	161	6.2
0913H20	87-309H3 x 9911H49, 9911	16960	54.24	15.63	0.0	0.0	152	4.9
R080H20	87-309H3 x R980	16740	53.43	15.66	1.4	0.0	153	5.3
R020H20	87-309H3 x R920 (C94)	16630	54.59	15.25	12.7	0.0	156	4.6
Z012H20	87-309H3 x Polish 2	16380	49.77	16.46	3.5	0.0	159	5.4
Z010H20	87-309H3 x Polish 1-7	16320	48.22	16.93	0.4	0.0	154	5.9
Y048H20	87-309H3 x Y948 (C93)	16100	49.22	16.36	0.0	0.0	152	4.5
Z014H20	87-309H3 x Polish 4	15710	46.45	16.93	0.8	0.0	161	5.4
C790-68H26 x multigerms								
R070H18	88-790-68H26 x R971-R980	17790	55.92	15.93	5.5	0.0	155	4.4
0913H18	88-790-68H26 x 9911H49, 9911	17730	55.75	15.90	0.4	0.0	160	4.4
Y931SH18	88-790-68H26 x Y731S (C31/6)	17610	53.98	16.33	0.0	0.0	157	4.1
Z010H18	88-790-68H26 x Polish 1-7	17530	51.10	17.14	0.9	0.0	152	4.9

TEST 191. HYBRID PERFORMANCE OF MULTIGERM GERMPLASM, SALINAS, CA., 1991
(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	Powdery Mildew Rating
C790-68H26 x multigerms (cont.)								
Y954H18	88-790-68H26 x Y854 (C54)	17520	54.43	16.10	0.4	0.4	158	4.4
Y048H18	88-790-68H26 x Y948 (C93)	17440	53.04	16.43	0.0	0.0	155	4.4
Y047H18	88-790-68H26 x Y947 (C47)	17330	53.87	16.10	0.9	0.0	147	4.4
Y039H18	88-790-68H26 x Y939 (C39)	17180	53.04	16.19	1.9	0.0	149	3.6
R080H18	88-790-68H26 x R980	17130	53.42	16.04	2.9	0.5	142	4.8
R039C5H18	88-790-68H26 x R939C5(C39R5)	16820	52.93	15.89	2.3	1.0	152	2.8
R047C5H18	88-790-68H26 x R947C5(C47R5)	16530	52.30	15.81	3.9	0.0	148	4.3
R020H18	88-790-68H26 x R820 (C94)	16190	51.66	15.69	18.5	0.0	143	4.6
MEAN		17063	52.92	16.14	2.13	0.08	154.55	4.50
LSD (.05)		1203	3.71	0.41	3.20	0.52	10.10	0.89
C.V. (%)		7.32	7.12	2.61	152.26	697.74	6.63	20.13
F value		2.17**	4.48**	11.95**	11.37**	1.34NS	1.98**	9.03**

[1] 309H3 = C562CMS x C309. 790-68H26 = C309CMS x C790-68.

TEST 291. PERFORMANCE OF POPULATION HYBRIDS, SALINAS, CA., 1991

32 entries x 8 replications, RCB equalized
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: September 11-12, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	Powdery Mildew Rating
Checks								
4757	Beta (1/6/89)	18540	58.75	15.79	0.4	0.0	156	1.9
HH41	Holly (L41138)	17050	55.31	15.42	1.3	0.0	166	4.6
Rhizosen	Holly (L493302)	16540	52.71	15.70	1.3	0.0	156	5.2
6625	Beta 0011-1	16470	48.05	17.13	0.4	0.4	157	3.7
mm-popns x MM-popns								
R080H113	9867H67aa x R980	17180	54.45	15.78	2.4	0.0	145	3.8
R039C5H132	9865aa x R939C5 (C39R5)	17120	53.49	16.02	1.4	0.5	153	4.4
Z014H111	9859H6aa x Polish 4	17070	51.15	16.69	0.8	0.9	153	5.2
R047C5H113	9867H67aa x R947C5 (C47R5)	17040	53.98	15.80	1.4	0.0	152	4.7
R080H132	9865aa x R980	16960	52.35	16.19	2.8	0.0	152	5.5
R047C5H132	9865aa x R947C5 (C47R5)	16800	50.65	16.61	5.0	0.0	153	5.6
R039C5H113	9867H67aa x R939C5 (C39R5)	16550	53.87	15.41	1.0	0.5	149	2.9
Z012H111	9859H6aa x Polish 2	16500	50.73	16.25	2.7	0.0	155	5.1
Y039H132	9865aa x Y939 (C39)	16480	50.17	16.42	1.7	0.0	159	4.2
Y954H118	8855aa x Y854 (C54)	16480	51.21	16.10	0.0	0.0	159	4.4
Y048H132	9865aa x Y948 (C93)	16430	49.55	16.58	0.0	0.0	159	4.4
Y047H132	9865aa x Y947 (C47)	16130	49.38	16.34	4.5	0.0	163	4.8
R070H113	9867H67aa x R971-R980	16020	51.05	15.68	6.7	0.0	154	3.9
Z010H113	9867H67aa x Polish 1-7	15990	48.71	16.43	0.0	0.0	159	4.4
R020H132	9865aa x R920 (C94)	15670	50.94	15.40	21.5	0.0	157	5.2
Z010H111	9859H6aa x Polish 1-7	15490	47.48	16.31	0.6	0.0	149	5.4
mm-popns x popn-913								
0913H39	89-762-17CMS x 9911H49	18800	60.69	15.49	0.0	0.0	161	4.2
0913H26	87-309CMS x 9911H49	17610	54.87	16.03	0.0	0.0	149	5.8
0913H115	9887H86aa x 9911H49	17450	55.76	15.65	0.0	0.0	153	4.4
0913H20	87-309H3 x 9911H49	17080	53.82	15.89	0.0	0.0	161	5.4

TEST 291. PERFORMANCE OF POPULATION HYBRIDS, SALINAS, CA., 1991
(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Rating
mm-popns x popn-913 (cont.)								
0913H18	88-790-68H26 x 9911H49	17070	54.55	15.67	0.5	0.0	156	4.3
0913H113	9867H67aa x 9911H49	16900	54.37	15.53	0.0	0.0	153	4.9
0913H132	9865aa x 9911H49	16780	52.88	15.86	0.9	0.0	153	5.7
0864H13	9911H49aa x 9864	16620	53.82	15.44	0.5	0.0	143	4.3
0913H111	9859H6aa x 9911H49	16520	53.25	15.51	0.9	0.0	148	5.7
0913H133	9864aa x 9911H49	16420	52.27	15.73	0.8	0.0	156	3.3
0913H112	9866H80aa x 9911H49	15860	50.71	15.64	0.0	0.4	162	4.4
0913H114	9876H76aa x 9911H49	15500	51.03	15.20	0.0	0.0	148	5.1
MEAN		16722.25	52.56	15.93	1.86	0.09	154.72	4.58
LSD (.05)		1174.00	3.42	0.52	2.54	0.55	10.65	0.80
C.V. (%)		7.12	6.60	3.29	139.89	645.79	7.02	17.64
F value		3.05**	5.45**	6.10**	18.22**	1.20NS	1.86**	9.24**

[1] 9865, 9867H67, 9859H6, 8855, 9866H80, 9876H76, 9887H86, 9864 segregate for resistance to rhizomania ($\underline{R}_z$:$\underline{r}_z$) and are backcross developments from S^f,mm,A:aa populations. R980 is $\underline{R}_z$ version of C54. 9911H49 = S^f,MM,A:aa popn segregating for $\underline{R}_z$:$\underline{r}_z$.

TEST 491. GCA EVALUATION OF MONOGERM LINES, SALINAS, CA., 1991

32 entries x 8 replications, RCB equalized
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: September 16-17, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	NSSS %	RJAP %	Beets/100' No.	Bolters %	Powdery Mildew[2] Rating
Checks									
4757	Beta (1/6/89)	19350	59.80	16.19	2.82	85.2	156	0.0	1.6
6625	Beta 0011-1	16580	47.55	17.43	3.10	84.9	149	0.9	3.8
HH41	Holly (L41138)	16560	52.65	15.78	2.65	85.6	159	0.4	5.5
HH54	Holly (L543003)	16060	46.34	17.35	2.92	85.6	150	2.5	4.6
CMS Lines x R80									
R080H39	87-762-17CMS x R980	18370	59.28	15.50	2.82	84.6	145	1.5	4.2
R080H72	83-718HO x R980	18340	57.86	15.84	2.89	84.6	145	0.0	4.2
R080H89	88-790-68CMS x R980	17870	54.98	16.27	3.11	84.0	151	0.0	3.4
R080H18	88-790-68H26 x R980	17520	53.26	16.45	3.20	83.8	146	1.4	4.7
R080H42	C742-24HO x R980	17280	52.93	16.36	2.92	84.9	154	2.3	3.9
R080H3	F82-562HO x R980	17130	53.26	16.10	2.90	84.7	154	0.5	4.4
R080H70	C766-62HO x R980	17110	53.89	15.87	3.04	83.9	134	1.5	4.4
R080H26	87-309CMS x R980	16980	50.77	16.73	3.47	82.8	147	2.4	5.5
R080H8	F82-546H3 x R980	16960	53.93	15.74	3.90	84.4	147	0.0	3.6
R080H54	C767-46HO x R980	16380	50.05	16.38	3.28	83.4	143	2.0	3.9
R080H20	87-309H3 x R980	16350	50.44	16.20	3.02	84.3	150	1.0	5.6
aa-popns x R80									
R080H90	8790Laa x R980	17870	56.09	15.93	2.79	85.1	148	2.3	3.8
R080H67	8767aa x R980	17540	54.62	16.06	3.19	83.5	145	1.5	3.4
R080H123	9867mmaa x R980	17390	55.28	15.73	3.03	83.9	149	1.3	4.5
R080H131	9858aa x R980	17380	53.29	16.30	2.87	85.1	146	1.5	4.3
R080H133	9864aa x R980	17110	53.96	15.85	2.77	85.1	153	5.6	3.8
R080H121	9859aa x R980	17100	51.93	16.48	3.05	84.4	147	4.2	5.4
R080H112	9866H80aa x R980	17090	51.59	16.54	2.94	84.9	145	3.1	4.1
R080H115	9887H86aa x R980	17070	53.13	16.09	3.10	83.9	150	2.3	3.9

TEST 491. GCA EVALUATION OF MONOGERM LINES, SALINAS, CA., 1991

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	NSSS %	RJAP %	Beets/100' No.	Bolters %	Powdery Mildew[2] Rating
aa-popns x R80 (cont.)									
R080H113	9867H67aa x R980	16870	53.10	15.92	2.76	85.2	145	2.0	3.8
R080H132	9865aa x R980	16620	50.71	16.38	3.16	83.9	153	4.2	5.4
R080H59	9776-1aa x R980	16390	52.49	15.61	2.93	84.2	143	0.5	3.9
R080H125	9887mmaa x R980	16360	50.72	16.14	3.08	84.0	143	1.5	4.9
R080H111	9859H6aa x R980	16330	50.99	16.03	2.62	86.0	152	3.2	5.1
R080H122	9866mmaa x R980	16000	49.71	16.13	2.63	86.0	143	4.6	4.6
R080H76	8776aa x R980	15660	48.97	16.00	3.03	84.1	145	1.5	4.3
R080H114	9876H76aa x R980	15580	49.43	15.72	2.89	84.5	146	1.9	4.8
R080H124	9876mmaa x R980	14620	48.50	15.05	3.19	82.6	135	1.6	5.1
MEAN		16931.80	52.55	16.13	2.97	84.47	147.30	1.84	4.32
LSD (.05)		1370.10	3.83	0.54	0.39	1.80	9.30	2.50	0.91
C.V. (%)		8.22	7.41	3.37	13.21	2.16	6.41	137.28	21.38
F value		3.40**	3.94**	6.03**	1.94**	1.64**	2.54**	2.41**	6.15**

[1]HO = CMS. aa = genetic male sterility. R980 = MM, O.P. line similar to C54 that segregates for $\underline{R}_z\underline{R}_z$. 9858, 9859,... are mm, S^f, A:aa popns that segregate for $\underline{R}_z\underline{R}_z$.

[2]Mean for ratings of 8/30 & 9/5/91. PM controlled with Bayleton. Ratings are for late in season after Bayleton lost its effacacy and probably reflect interactions between chemical and varietial control.

TEST 591. HYBRID PERFORMANCE OF SELECTED PROGENY LINES, SALINAS, CA., 1991

32 entries x 8 replications, RCB equalized
1-row plots, 18 ft. long

Planted: January 24, 1991
Harvested: September 16-17, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	NSSS %	RJAP %	Beets/ 100' No.	Bolters %	Powdery Mildew[2] Rating
Checks									
0913H132	9865aa x 9911H49	17490	54.26	16.16	3.6	81.7	155	0.0	5.7
6625	Beta 6625 (0011-1)	17130	48.83	17.54	2.9	85.9	152	0.0	4.4
Z010H111	9859H6aa x Polish 1-7	16910	49.55	17.09	3.1	84.9	144	0.5	6.0
US H11	Lot 786442	16160	53.49	15.10	2.8	84.6	155	0.0	7.1
C309H3 x HS Lines from C54									
Y054-38H20	87-309H3 x Y854-38	18280	55.48	16.47	3.2	83.9	152	0.0	5.4
Y054-2H20	87-309H3 x Y854-2	17980	56.03	16.05	2.9	84.8	161	0.4	4.6
Y054-23H20	87-309H3 x Y854-23	17960	54.98	16.35	3.1	83.9	153	0.0	5.6
Y054-63H20	87-309H3 x Y854-63	17230	51.82	16.63	3.1	84.3	154	0.0	6.4
R080H20	87-309H3 x R980	17130	51.66	16.59	3.0	84.7	149	0.4	6.4
Y054-12H20	87-309H3 x Y854-12	17090	52.54	16.30	2.9	84.9	154	0.0	5.3
Y054H20	87-309H3 x BYR Y854	16600	51.32	16.17	3.0	84.4	147	0.0	4.4
Y054-85H20	87-309H3 x Y854-85	16210	50.10	16.18	2.8	85.2	155	0.0	5.5
C309H3 x Progenies from popn-906 & -909									
0909-7H20	87-309H3 x 8909-7	17480	53.15	16.45	3.0	84.5	156	0.4	5.8
0913H20	87-309H3 x 9911H49	17360	53.15	16.37	3.2	83.6	154	0.5	5.9
9912H20	87-309H3xRZM 8909-11	16990	51.93	16.37	3.4	82.9	157	1.3	6.3
0909-37H20	87-309H3 x 8909-37	16960	52.38	16.23	3.0	84.6	159	0.0	4.9
0909-48H20	87-309H3 x 8909-48	16910	51.55	16.42	2.9	84.8	157	0.0	6.4
0906-7H20	87-309H3 x 8906-7	16780	51.52	16.34	3.4	82.8	149	0.0	6.6
0906-4H20	87-309H3 x 8906-4	16780	51.43	16.34	3.2	83.7	162	0.0	6.7
0909-34H20	87-309H3 x 8909-34	16740	50.71	16.51	2.9	85.0	154	0.0	4.8
S_1 Lines from popn-790 x R980									
R080H30	8790-15aa x R980	19030	58.03	16.41	2.8	85.4	152	0.0	2.3
R080H33	8790-54aa x R980	18770	58.31	16.11	2.7	85.6	155	0.4	4.6
R080H29	8790- 6aa x R980	18200	55.98	16.27	2.7	85.7	154	0.9	4.7
R080H18	88-790-68H26 x R980	18110	54.15	16.73	3.1	84.5	147	3.1	5.1

TEST 591. HYBRID PERFORMANCE OF SELECTED PROGENY LINES, SALINAS, CA., 1991

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	NSSS %	RJAP %	Beets/100' No.	Bolters %	Powdery Mildew[2] Rating
S_1 Lines from popn-790 x R980 (cont.)									
R080H89	88-790-68CMS x R980	18090	54.37	16.66	2.8	85.9	145	1.0	3.6
R080H90	8790Laa x R980	18080	55.70	16.21	3.2	83.6	154	2.2	5.1
R080H34	8790-55aa x R980	17740	53.81	16.50	2.7	86.0	146	0.5	4.0
R080H31	8790-23aa x R980	17640	54.70	16.15	2.9	84.7	148	1.9	5.3
R080H26	87-309CMS x R980	17510	52.04	16.82	3.3	83.6	159	3.0	6.3
R080H35	8790-61aa x R980	16820	52.82	15.91	2.6	85.8	140	1.0	5.2
R080H36	8790-71aa x R980	16060	50.55	15.92	2.8	85.1	146	0.5	4.6
R080H32	8790-47aa x R980	15030	46.65	16.13	2.7	85.7	147	0.0	3.8
MEAN		17288.41	52.91	16.36	2.99	84.59	152.27	0.57	5.27
LSD (.05)		1189.02	3.41	0.50	0.36	1.59	9.92	1.65	0.94
C.V. (%)		6.98	6.54	3.13	12.22	1.91	6.61	293.78	17.12
F value		3.80**	4.35**	4.90**	3.36**	3.05**	2.12**	2.17**	10.72**

[1]BYR Y854 = C54. R980 = C54R_z. Popn-906 & -909 = MM, S^f, A:aa, R_z populations. 8790-#'s = S_1 lines from source popn-790 (C4) = 8790L.

[2]Mean for ratings of 8/30 & 9/5/91. PM controlled with Bayleton. Ratings are for late in season after Bayleton lost its effacacy and probably reflect interactions between chemical and varietial control.

TEST 391. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1991

32 entries x 8 reps, RCB
1-row plots, 38 ft. long

Planted: January 24, 1991
Harvested: September 18-19, 1991

Code[1]	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score[2] Avg
4	9BG6381	Beta	20030	60.14	16.65	0.0	0.0	145	2.3
21	6BG6209	Beta	19620	60.01	16.35	0.0	0.0	136	2.0
27	9BG6374	Beta	19550	59.64	16.39	0.0	0.0	138	1.8
7	4757	Beta	19060	58.58	16.27	0.6	0.0	147	1.6
6	7BG6103	Beta	18730	57.56	16.28	0.3	0.0	133	1.5
24	8BG6169	Beta	18520	56.26	16.47	0.0	0.0	148	3.5
10	Rhizosen	Holly	17960	54.92	16.35	0.2	0.5	142	4.3
2	H87545	Sprec	17870	54.87	16.29	0.0	0.0	147	3.6
32	R080H132	USDA	17800	53.82	16.55	2.6	0.0	144	4.8
14	86C 15-014	Holly	17610	53.59	16.43	0.0	0.0	142	3.9
12	HH-37	Holly	17520	54.59	16.02	0.0	0.2	151	4.1
19	4581	Beta	17470	55.51	15.74	0.7	0.0	147	2.2
13	HH-66	Holly	17440	54.18	16.10	0.2	0.0	144	4.9
18	Hill 2	H-MH	17350	53.12	16.34	0.0	0.0	145	1.8
5	H86558	Sprec	17310	52.52	16.48	0.0	0.0	152	2.4
16	86-84C65-05	Holly	17160	50.99	16.81	0.9	0.0	143	3.7
23	88-1459-049	Holly	17150	53.10	16.15	0.0	0.0	144	4.4
15	H87497	Sprec	17080	52.16	16.37	0.0	0.0	146	4.7
9	9BG6276	Beta	17010	51.49	16.50	0.0	0.0	139	4.3
3	SS-NB3	Sprec	16970	53.15	15.97	0.0	0.0	140	3.4
31	89N 158-02	Holly	16910	50.16	16.86	0.9	0.0	145	3.1
11	HH-41	Holly	16820	55.45	15.17	0.9	0.0	147	5.2
17	85C 62-016	Holly	16730	52.43	15.97	0.0	0.0	142	4.6
1	88C 155-016	Holly	16710	52.36	15.95	0.4	0.2	149	5.1

TEST 391. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1991

(continued)

Code[1]	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	PM Score[2] Avg
22	SS-NB2	Sprec	16700	50.58	16.51	0.0	0.0	145	4.1
26	H89238	Sprec	16680	51.77	16.11	0.0	0.0	142	2.5
29	H88242	Sprec	16610	51.43	16.15	0.4	0.0	149	4.8
25	H87354	Sprec	16580	50.60	16.37	0.0	0.0	144	3.8
20	HH-54	Holly	16560	47.65	17.39	2.5	0.0	146	4.1
28	HH-81	Holly	16220	51.13	15.84	0.0	0.0	144	5.0
30	SS-Z2	Sprec	15920	47.37	16.81	0.0	0.0	140	4.0
8	SS-Z1	Sprec	15800	50.14	15.74	0.0	0.0	145	4.2
MEAN			17420.63	53.48	16.29	0.33	0.03	144.12	3.61
LSD (.05)			1038.00	2.86	0.40	0.75	0.22	7.13	0.83
C.V. (%)			6.05	5.42	2.46	229.59	775.44	5.02	23.29
F value			7.94**	10.05**	8.13**	5.73**	1.53*	2.46**	14.85**

TEST 391. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1991

(continued)

Code[1]	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
4	9BG6381	18850	314	94.2	1173	273	1405	213	6492
21	6BG6209	18370	306	93.7	1242	276	1562	214	6903
27	9BG6374	18330	307	93.8	1219	283	1484	222	6806
7	4757	17780	303	93.3	1287	311	1567	243	7319
6	7BG6103	17420	303	93.0	1313	303	1594	269	7601
24	8BG6169	17170	305	92.7	1348	295	1633	300	7966
10	Rhizosen	16900	308	94.1	1064	309	1414	193	6445
2	H87545	16740	305	93.7	1130	267	1473	237	6865
32	R080H132	16490	307	92.7	1311	223	1717	318	8092
14	86C 15-014	16330	305	92.7	1284	329	1556	312	8004
12	HH-37	16400	300	93.6	1118	322	1392	232	6808
19	4581	16170	291	92.5	1304	344	1672	258	7830
13	HH-66	16260	300	93.2	1185	282	1554	253	7281
18	Hill 2	16110	303	92.8	1244	301	1630	282	7809
5	H86558	16130	307	93.2	1178	272	1604	261	7435
16	86-84C65-05	16040	315	93.5	1114	255	1535	266	7258
23	88-1459-049	16000	301	93.3	1154	336	1385	276	7257
15	H87497	16030	307	93.9	1052	280	1451	221	6704
9	9BG6276	16030	311	94.3	979	311	1377	189	6322
3	SS-NB3	15760	297	92.9	1210	286	1458	310	7594
31	89N 158-02	15910	317	94.1	998	258	1350	248	6633
11	HH-41	15690	283	93.3	1131	336	1433	216	6807
17	85C 62-016	15510	296	92.7	1223	337	1503	298	7764
1	88C 155-016	15600	298	93.4	1110	378	1408	232	7049

TEST 391. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1991

(continued)

Code[1]	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
22	SS-NB2	15440	305	92.5	1262	251	1514	384	8307
26	H89238	15510	300	93.0	1166	261	1600	274	7512
29	H88242	15490	301	93.2	1123	304	1465	269	7286
25	H87354	15460	305	93.3	1118	276	1513	272	7333
20	HH-54	15740	331	95.0	826	282	1270	169	5763
28	HH-81	15130	296	93.3	1087	308	1471	246	7091
30	SS-Z2	14870	314	93.4	1048	264	1473	290	7358
8	SS-Z1	14600	291	92.4	1201	385	1583	280	7961
MEAN		16258.10	304.14	93.32	1162.53	296.76	1501.47	257.57	7239.22
LSD (.05)		988.10	8.40	0.66	126.30	54.76	120.50	48.31	668.50
C.V. (%)		6.17	2.80	0.72	11.02	18.72	8.15	19.03	9.37
F value		8.04**	8.43**	6.39**	6.16**	3.42**	5.46**	6.37**	5.94**

[1]Variety 32 (R080H132 = 9865aa x R980) was a filler from USDA. 9865 is approximately C309$\underline{R}_z$. R980 is approximately C54$\underline{R}_z$.

[2]PM was scored on a scale of 0 to 9 where 9 = 90-100% of leaf area covered. PM was scored on 8/29/91 and 9/5/91. PM was controlled with Bayleton. Ratings are for late season development after Bayleton lost its efficacy and probably reflect interactions between chemical control and varietal reaction.

Note: Test was highly uniform and very good growth occurred. Beet western yellows was 100% by May 1. Beet yellows virus appeared to be unimportant. Black aphids were severe and required chemical control on 4/22/91 and 6/1/91. Field soil samples tested positive for BNYVV but no symptoms of rhizomania were observed.

TEST 1191. NONINOCULATED BYV EVALUATION OF SUGARBEET x B.MARITIMA GERMPLASM, 1991

8 entries x 2 virus trtmts x 8 reps, Split-plot
1-row plots, 18 ft. long, 32 blocks

Planted: February 12, 1991
Harvested: September 20, 1991
Not BYV Inoculated

Variety	Description[4]	Acre Yield: Sugar[5] lbs	Acre Yield: Sugar[6] lbs	Acre Yield: Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters[2] %
768	Inc. 868 (US 75)	7738	9866	36.49	13.50	0.2	137	81.1	5.5	0.2
U86-37	Inc. C37	9585	10878	36.59	14.86	0.0	141	80.3	6.6	0.0
R080	RZM R980	11190	12491	41.97	14.87	0.5	137	81.5	4.1	0.0
Y054	BYR-ER-PMR Y854 (C54)	10970	12631	41.78	15.12	0.5	149	82.0	2.3	0.2
R722 (C50)	Inc. F_2 (Y54 x B.m.)	8426	9007	32.47	13.95	0.0	146	80.6	4.0	23.9
R022Y1	Inc. R922Y & S	10140	11699	40.77	14.35	0.5	142	79.9	3.9	0.3
R022R2	RZM R922R	9081	10522	38.91	13.53	0.0	147	79.5	4.7	10.8
89-C58	Inc. WB1-2	8930	10837	37.98	14.23	0.0	129	77.1	3.6	19.7
Mean		9508	10991	38.37	14.30	0.2	140.9	80.3	4.3	6.9
LSD (.05)		802.5	1337	4.42	0.65	0.7	6.3	2.5	0.6	4.4
C.V. (%)		13.9	13.9	13.13	4.60	480.5	7.3	3.1	19.7	55.6
F value for variety		18.3**	18.3**	10.9**	30.4**	1.0NS	8.5**	8.8**	36.9**	41.8**
F value for virus treatments		185.9**	185.9**	124.5**	31.8**	2.7NS	0.2NS	9.0*	17.6**	0.4NS
F value for variety x virus		2.0NS	2.0NS	1.9NS	1.3NS	0.8NS	1.0NS	1.9NS	0.7	5.6**

1 BYV inoculated means and % loss are summarized on the following page.

2 Means over both virus treatments.

3 PM rated 8/15/91, 8/26/91, & 9/6/91 on a scale of 0 to 9. PM was controlled with Bayleton until late in season.

4 R722 = F_3 (Y54 x Beta maritima accessions). R022Y1 = 1 cycle of selection from R722 (C50) for resistance to BYV (mother root selection based upon individual plant performance for root type and gross sugar). R022R2 = 2 cycles of selection from R722 for resistance to rhizomania. 89-C58 = development of Dr. E.D. Whitney from crosses between sugarbeet and four B. maritima accessions.

5 Variety means over both virus treatments analyzed as RCB (8 x 16 reps).

6 Variety means for noninoculated treatment.

Downey mildew infection occurred in plots of R722, R022Y1, and R022R2 to a moderate level.

TEST 1191. BYV INOCULATED EVALUATION OF SUGARBEET x B.MARITIMA GERMPLASM, 1991

8 entries x 2 virus trtmts x 8 reps, Split-plot
1-row plots, 18 ft. long, 32 blocks

Planted: February 12, 1991
Harvested: September 20, 1991
BYV Inoculated: May 10, 1991

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows Rating[7]	Clean Beets %
768	Inc. 868 (US 75)	5611	43.13	21.69	40.56	12.92	0.6	78.0	6.5	92.2
U86-37	Inc. C37	8292	23.77	28.64	21.73	14.44	0.4	81.2	4.3	92.2
R080	RZM R980	9894	20.79	33.50	20.16	14.76	0.1	82.0	5.5	93.6
Y054	BYR-ER-PMR Y854 (C54)	9310	26.29	31.02	25.74	15.00	0.1	82.0	5.8	94.4
R722 (C50)	Inc. F_2 (Y54 x B.m.)	7845	12.90	28.13	13.37	13.89	0.1	79.2	5.0	86.0
R022Y1	Inc. R922Y & S	8582	26.65	30.62	24.90	14.00	0.4	81.2	5.5	92.9
R022R2	RZM R922R	7640	27.39	28.54	26.68	13.34	0.2	76.9	6.3	89.3
89-C58	Inc. WB1-2	7023	35.19	26.77	29.52	13.07	1.2	75.6	3.5	73.4
Mean		8025		28.61		13.93		79.51	5.30	89.24
LSD		1337		4.42		0.65		2.45	0.67	4.37
C.V. (%)		13.99		13.13		4.60		3.10	12.67	7.60
F value for variety		18.28**		10.93**		30.35**		8.83**	18.23**	20.47**
F value for virus treatments		185.96**		124.51**		31.80**		8.98*		5.58*
F value for variety x virus		1.96NS		1.87NS		1.26NS		1.92NS		1.08NS

[7] Mean virus yellows scored from 6/18/91, 6/28/91 & 7/25/91. Score from 0 to 9 (100% of matured leaf canopy yellowed.

TEST 1291. NONINOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 23-25, 1991
Not BYV Inoculated

Variety	Description[4]	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters %
Checks										
4757	Beta (1/6/89)	12900	15465	50.10	15.39	0.0	156	84.2	4.3	0.0
Vyxen	Hilleshog (1/25/91)	12540	15029	49.11	15.29	0.0	150	83.7	5.0	0.0
Rhizosen	Holly (L493302)	12290	14471	47.11	15.38	0.4	155	86.7	7.0	0.9
HH41	Holly (L412305)	12290	13907	48.55	14.33	0.0	149	84.7	7.4	0.0
6625	Beta (0011-1)	10700	13481	41.01	16.47	0.0	152	84.2	5.8	0.0
Females x R80										
R080H89	88-790-68CMS x R980	13150	15087	50.10	15.03	0.0	142	84.2	4.8	0.5
R080H132	9865aa x R980	13010	15311	49.22	15.57	0.0	147	85.3	6.7	0.0
R080H26	87-309CMS x R980	12890	15012	46.45	16.15	0.0	151	83.1	7.4	0.5
R080H42	C742-24HO x R980	12470	13742	45.34	15.15	0.0	143	83.8	4.5	1.0
R080H133	9864aa x R980	12470	13911	47.00	14.77	0.0	147	84.3	5.7	1.4
R080H113	9867H67aa x R980	12340	13104	43.90	14.90	0.0	142	83.1	5.3	0.0
R080H70	C766-62HO x R980	12280	13747	46.00	14.94	0.0	143	83.5	5.8	0.0
R080H54	C767-46HO x R980	12190	13538	43.20	15.67	0.0	140	83.6	5.4	0.0
R080H39	89-762-17CMS x R980	12180	14258	49.39	14.46	0.0	143	84.6	5.4	0.0
R080H115	9887H86aa x R980	11960	13795	46.78	14.73	0.0	139	83.3	5.5	0.0
R080H112	9866H80aa x R980	11750	12529	40.68	15.42	0.0	139	84.0	5.1	0.5
R080H111	9859H6aa x R980	11660	13330	45.03	14.84	0.0	145	82.2	6.3	0.0
R080H114	9876H76aa x R980	11650	13869	45.65	15.17	0.0	141	82.4	5.8	0.0
Popn-aa x popn-913										
0913H132	9865aa x 9911H49	12940	15255	49.33	15.46	0.0	145	83.7	6.5	0.0
0913H113	9867H67aa x 9911H49	12520	14637	49.44	14.82	0.0	145	83.6	5.5	0.0
0913H133	9864aa x 9911H49	11910	13954	46.76	14.94	0.0	145	85.4	5.5	0.0
0913H111	9859H6aa x 9911H49	11820	13836	47.57	14.56	0.0	147	81.8	6.6	0.0

TEST 1291. NONINOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, 1991

(continued)

Variety	Description[4]	Acre Yield Sugar[5] lbs	Sugar[6] lbs	Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters %
(C309 x C790-68) x Male										
Y931SH18	88-790-68H26 x Y731S	14490	16001	50.66	15.81	0.0	147	84.1	5.5	0.0
Y039H18	88-790-68H26 x Y939	13760	15032	47.89	15.69	0.0	149	85.2	5.0	0.0
Y047H18	88-790-68H26 x Y947	13760	15118	49.55	15.29	0.0	145	84.2	5.7	0.0
R039C5H18	88-790-68H26 x R939C5	13410	15208	49.77	15.27	0.4	151	85.2	4.8	0.4
Y048H18	88-790-68H26 x Y948	13180	14849	45.56	16.30	0.0	147	83.0	6.0	0.5
R080H18	88-790-68H26 x R980	12790	14675	47.89	15.33	0.0	133	83.3	6.2	0.0
R070H18	88-790-68H26 x R971-80	12720	14555	48.22	15.08	0.0	150	81.7	6.3	0.5
0913H18	88-790-68H26 x 9911H49	12660	14981	50.22	14.87	0.0	147	80.9	5.9	0.0
R047C5H18	88-790-68H26 x R947C5	12590	13981	46.11	15.17	0.5	153	84.8	6.8	0.0
Z010H18	88-790-68H26 x Polish Composite	11970	14107	44.45	15.94	0.0	145	84.8	6.9	0.0
Mean		12538	14368	47.1	15.26	0.04	146.0	83.3	5.82	0.20
LSD (.05)		1093	1410	4.64	0.72	0.37	8.3	2.5	0.89	0.74
C.V. (%)		8.01	8.0	7.9	3.4	920.74	6.7	2.1	16.60	442.19
F value for variety		3.56**	3.6	4.1**	4.82**	1.9NS	2.7**	1.8*	6.43**	1.88*
F value for virus			329.4	352.7**	187.35**	2.4NS	0.1	31.1*	3.68NS	0.48
F value for variety x virus			1.9*	1.5NS	1.3NS	0.94	0.9	1.1NS	1.27NS	1.17NS

[1]BYV inoculated means and % loss are summarized on the following page.

[2]Means over both virus treatments.

[3]PM rated 8/15/91, 8/26/91, & 9/6/91 on a scale of 0 to 9. PM was not controlled in tests 1291 thru 1591 and was quite severe on susceptible varieties.

[4]R980 = C54R_z. 9911H49 = popn-913 = MM,S^f,A:aa,R_z popn. R939C5 = C39R. Y939 = C39. R947C5 = C47R. Y947 = C47. Y948 = C93. Y731S = C31/6. 9859-9887 = mm,S^f,A:aa,R_z popns.

[5]Variety means over both virus treatments analyzed as RCB (32 x 8 reps).

[6]Variety means for noninoculated treatment.

TEST 1291. BYV INOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 23-25, 1991
BYV Inoculated: May 10, 1991

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows Rating[7]
Checks									
HH41	Holly (L412305)	10674	23.25	37.69	22.45	14.16	0.2	84.2	5.7
4757	Beta (1/6/89)	10327	33.22	35.92	28.30	14.38	1.0	84.1	4.9
Rhizosen	Holly (L493302)	10114	30.11	34.36	27.05	14.73	0.7	84.1	6.1
Vyxen	Hilleshog (1/25/91)	10047	33.15	33.81	31.14	14.87	0.4	83.0	4.8
6625	Beta (0011-1)	7912	41.31	26.05	36.46	15.20	1.3	82.9	6.3
Females x R80									
R080H113	9867H67aa x R980	11571	11.70	38.24	12.89	15.14	-0.2	84.8	5.3
R080H89	88-790-68CMS x R980	11212	25.68	37.89	24.37	14.80	0.2	83.3	4.6
R080H42	C742-24HO x R980	11206	18.45	37.57	17.06	14.95	0.2	82.8	4.8
R080H133	9864aa x R980	11028	20.72	37.90	19.36	14.57	0.2	83.8	5.0
R080H112	9866H80aa x R980	10961	12.51	36.97	9.16	14.84	0.6	83.6	4.8
R080H54	C767-46HO x R980	10833	19.98	36.24	16.11	14.99	0.7	82.5	4.9
R080H70	C766-62HO x R980	10821	21.28	37.25	19.02	14.53	0.4	81.7	3.8
R080H26	87-309CMS x R980	10764	28.30	35.92	22.59	15.00	1.2	82.6	4.8
R080H132	9865aa x R980	10717	30.00	35.47	27.91	15.10	0.5	81.9	5.2
R080H115	9887H86aa x R980	10122	26.63	34.57	26.13	14.65	0.1	81.5	5.1
R080H39	89-762-17CMS x R980	10106	29.12	35.69	27.75	14.15	0.3	81.9	5.1
R080H111	9859H6aa x R980	9994	25.03	34.69	22.91	14.41	0.4	81.9	5.1
R080H114	9876H76aa x R980	9429	32.01	33.48	26.58	14.10	1.1	81.2	5.3
Popn-aa x Popn-913									
0913H132	9865aa x 9911H49	10615	30.42	36.36	26.25	14.58	0.9	81.2	4.3
0913H113	9867H67aa x 9911H49	10402	28.93	35.36	28.42	14.71	0.1	82.0	5.1
0913H133	9864aa x 9911H49	9863	29.32	34.03	27.29	14.49	0.5	83.4	5.3
0913H111	9859H6aa x 9911H49	9805	29.13	34.30	27.94	14.28	0.3	83.4	5.6

TEST 1291. BYV INOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, 1991

(continued)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows Rating[7]
(C309 x C790-68) x Male									
Y931SH18	88-790-68H26 x Y731S	12970	18.94	43.02	15.15	15.07	0.7	83.6	4.6
Y039H18	88-790-68H26 x Y939	12482	16.96	38.80	19.00	16.05	-0.4	83.4	4.5
Y047H18	88-790-68H26 x Y947	12394	18.02	40.85	17.64	15.15	0.1	83.3	4.3
R039C5H18	88-790-68H26 x R939C5	11607	23.68	38.58	22.53	15.06	0.2	81.8	4.8
Y048H18	88-790-68H26 x Y948	11515	22.45	37.02	18.82	15.52	0.8	82.0	4.7
R047C5H18	88-790-68H26 x R947C5	11191	19.96	36.80	20.17	15.21	0.0	83.6	4.5
R080H18	88-790-68H26 x R980	10905	25.69	35.93	24.99	15.19	0.1	81.9	4.2
R070H18	88-790-68H26 x R971-80	10888	25.19	35.03	27.32	15.54	-0.5	83.2	4.7
0913H18	88-790-68H26 x 9911H49	10331	31.04	36.25	27.79	14.28	0.6	82.0	4.6
Z010H18	88-790-68H26 x Polish Composite	9831	30.31	31.52	29.17	15.60	0.3	82.2	6.6
Mean		10707		36.05		14.85		82.78	4.97
LSD (.05)		1410		4.64		0.72		2.47	0.52
C.V. (%)		8.01		7.95		3.40		2.12	10.45
F value for variety		3.56**		4.05**		4.82**		1.78*	5.20**
F value for virus		329.36**		352.68**		187.35**		31.06*	
F value for variety x virus		1.86*		1.50NS		1.31NS		1.09NS	

[7]Mean virus yellows scored from 6/18/91, 6/28/91 & 7/18/91. Score from 0 to 9 (100% of matured leaf canopy yellowed.

TEST 1391. NONINOCULATED PERFORMANCE OF PROGENY LINE HYBRIDS, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 23-25, 1991
Not BYV Inoculated

Variety	Description[4]	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating
Checks									
Y931SH20	87-309H3 x Y731S(C31/6)	12210	13318	44.01	15.12	0.0	149	84.1	7.9
4757	Beta (1/6/89)	11130	14299	46.00	15.53	0.0	145	85.0	6.5
HM2009	Hilleshog (1/25/91)	10710	12789	40.79	15.62	0.0	149	85.6	7.8
Vyxen	Hilleshog (1/25/91)	10370	12028	41.49	14.44	0.0	144	83.3	6.9
Z010H20	87-309H3 x Polish (C)	9899	11816	38.02	15.47	0.0	142	83.7	8.2
6625	Beta 6625 (0011-1)	9812	12909	39.68	16.26	0.4	147	84.8	7.3
C309H3 x HS Lines from C54									
R080H20	87-309H3 x R980	11660	13066	43.79	14.91	0.0	146	82.7	7.5
Y054-38H20	87-309H3 x Y854-38	11270	13405	44.56	14.99	0.0	149	82.9	7.8
Y054H20	87-309H3 x BYR Y854	11050	13060	44.23	14.68	0.0	149	84.3	7.4
Y054-12H20	87-309H3 x Y854-12	10770	14144	46.34	15.28	0.0	145	83.7	7.8
Y054-2H20	87-309H3 x Y854-2	10700	12987	45.12	14.36	0.0	143	85.6	7.5
Y054-23H20	87-309H3 x Y854-23	10680	12926	43.90	14.75	0.0	149	85.0	7.8
Y054-85H20	87-309H3 x Y854-85	10580	12699	44.48	14.23	0.0	146	82.7	8.0
Y054-63H20	87-309H3 x Y854-63	10330	12369	41.98	14.77	0.0	142	83.4	8.2
C309H3 x Lines from popn-906 & -909									
0909-37H20	87-309H3 x 8909-37	11770	14046	47.22	14.80	0.0	150	83.0	7.3
0909-7H20	87-309H3 x 8909-7	11520	12922	43.12	14.93	0.0	152	81.3	7.6
0906-7H20	87-309H3 x 8906-7	11080	13468	43.68	15.43	0.0	140	82.9	8.3
9912H20	87-309H3 x RZM 8909-11	10960	12695	42.35	14.98	0.0	146	83.2	8.3
0906-4H20	87-309H3 x 8906-4	10880	13932	45.78	15.24	0.0	154	81.9	8.2
0909-34H20	87-309H3 x 8909-34	10880	12634	41.57	15.20	0.0	151	83.1	7.3
0909-48H20	87-309H3 x 8909-48	10710	12780	40.79	15.64	0.0	147	82.7	8.0
0913H20	87-309H3 x 9911,9911H49	10450	11774	40.13	14.66	0.0	149	82.6	8.1

TEST 1391. NONINOCULATED PERFORMANCE OF PROGENY LINE HYBRIDS, 1991

(continued)

Variety	Description[4]	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating
S_1 lines from popn-790 x R80									
R080H33	8790-54aa x R980	12770	15327	49.33	15.52	0.0	147	84.7	6.1
R080H30	8790-15aa x R980	12620	13892	46.72	14.92	0.0	139	83.0	4.5
R080H29	8790-6aa x R980	12400	13637	47.00	14.52	0.0	145	83.5	7.1
R080H31	8790-23aa x R980	12310	14315	46.64	15.34	0.0	142	83.3	7.8
R080H89	88-790-68CMS x R980	11860	14401	47.67	15.11	0.5	140	83.9	6.2
R080H90	8790Laa x R980	11480	12958	42.46	15.25	0.0	146	82.8	7.1
R080H34	8790-55aa x R980	11470	14055	46.45	15.15	0.0	140	83.6	6.5
R080H36	8790-71aa x R980	11030	13221	43.76	15.08	0.0	136	85.0	6.3
R080H35	8790-61aa x R980	11000	13117	44.67	14.66	0.9	140	83.2	6.1
R080H32	8790-47aa x R980	10130	12962	43.65	14.83	0.0	145	83.3	6.0
MEAN		11140	13248	43.98	15.05	0.06	145	83.56	7.29
LSD (.05)		1454	2302	6.77	0.76	NS	7.6	2.44	1.62
C.V. (%)		13.24	14.7	12.85	3.70	963.31	6.8	2.09	15.55
F value for variety		2.14**	3.2**	4.68**	2.45**	0.95NS	2.3**	1.85*	4.80**
F value for virus treatment			545.4**	964.01**	28.35*	2.99NS	0.1	8.68NS	3.52NS
F value for variety x virus			1.0NS	1.10NS	1.90**	0.94NS	0.6NS	1.21NS	0.85NS

[1]BYV inoculated means and % loss are summarized on the following page.

[2]Means over both virus treatments.

[3]PM rated 8/15/91, 8/26/91, & 9/6/91 on a scale of 0 to 9. PM was not controlled in tests 1291 thru 1591 and was quite severe on susceptible varieties.

[4]R980 = C54R_Z. BYR Y854 = C54. Y854-#'s = Half-sib lines from Y54 selected for per se performance under BYV conditions in 1989. 8906-#'s, 8909-#'s = S_1 and FS lines selected under rhizomania conditions. 8790-#'s = S_1 lines selected for per se performance at Salinas under BYV and Brawley under LIYV conditions in 1989.

[5]Variety means over both virus treatments analyzed as RCB (32 x 8 reps).

[6]Variety means for noninoculated treatment.

TEST 1391. BYV INOCULATED PERFORMANCE OF PROGENY LINE HYBRIDS, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 23-25, 1991
BYV Inoculated: May 10, 1991

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows[7] Rating
Checks									
Y931SH20	87-309H3 x Y731S(C31/6)	11098	16.67	37.82	14.1	14.55	0.6	82.4	4.4
Vyxen	Hilleshog (1/25/91)	8707	27.61	28.49	28.9	14.78	-0.3	82.3	5.1
HM2009	Hilleshog (1/25/91)	8640	32.44	29.71	27.2	14.46	1.2	82.1	5.3
Z010H20	87-309H3 x Polish (C)	7982	32.45	26.72	29.7	14.93	0.5	83.4	5.9
4757	Beta (1/6/89)	7960	44.33	28.62	37.8	13.95	1.6	81.0	6.1
6625	Beta 6625 (0011-1)	6715	47.98	21.74	45.2	15.44	0.8	83.4	6.3
C309H3 x HS Lines from C54									
R080H20	87-309H3 x R980	10255	21.51	34.59	21.0	14.74	0.2	83.2	5.2
Y054-38H20	87-309H3 x Y854-38	9126	31.92	31.93	28.4	14.25	0.7	82.8	4.8
Y054H20	87-309H3 x BYR Y854	9035	30.82	31.26	29.3	14.45	0.2	82.9	4.9
Y054-85H20	87-309H3 x Y854-85	8463	33.35	28.27	36.5	14.92	-0.7	85.6	5.4
Y054-23H20	87-309H3 x Y854-23	8433	34.76	30.37	30.8	13.86	0.9	82.9	4.8
Y054-2H20	87-309H3 x Y854-2	8417	35.19	30.60	32.2	13.68	0.7	83.1	5.2
Y054-63H20	87-309H3 x Y854-63	8285	33.02	28.15	32.9	14.63	0.1	83.1	4.8
Y054-12H20	87-309H3 x Y854-12	7394	47.72	26.54	42.7	13.93	1.4	82.0	5.0
C309H3 x Lines from popn-906 & -909									
0909-7H20	87-309H3 x 8909-7	10122	21.67	36.42	15.5	13.88	1.1	81.1	5.3
0909-37H20	87-309H3 x 8909-37	9494	32.41	32.70	30.8	14.48	0.3	81.4	5.1
9912H20	87-309H3 x RZM 8909-11	9230	27.29	32.48	23.3	14.20	0.8	82.7	5.2
0913H20	87-309H3 x 9911,9911H49	9129	22.46	31.93	20.4	14.29	0.4	81.9	4.8
0909-34H20	87-309H3 x 8909-34	9118	27.83	31.70	23.7	14.33	0.9	81.5	4.7
0906-7H20	87-309H3 x 8906-7	8702	35.39	30.51	30.1	14.25	1.2	80.5	5.7
0909-48H20	87-309H3 x 8909-48	8638	32.41	29.26	28.3	14.78	0.9	82.5	4.3
0906-4H20	87-309H3 x 8906-4	7821	43.86	27.49	40.0	14.20	1.0	79.2	5.3

TEST 1391. BYV INOCULATED PERFORMANCE OF PROGENY LINE HYBRIDS, 1991

(continued)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows Rating[7]
S_1 lines from popn-790 x R80									
R080H30	8790-15aa x R980	11355	18.26	37.58	19.6	15.09	-0.2	82.7	4.3
R080H29	8790- 6aa x R980	11159	18.17	37.25	20.9	14.97	-0.4	84.3	4.4
R080H31	8790-23aa x R980	10315	27.94	35.81	23.2	14.44	0.9	84.2	4.8
R080H33	8790-54aa x R980	10213	33.36	34.79	29.5	14.67	0.9	84.0	4.2
R080H90	8790Laa x R980	9994	22.88	34.70	18.3	14.38	0.9	82.3	4.7
R080H89	88-790-68CMS x R980	9319	35.29	31.02	34.9	14.97	0.1	83.3	4.4
R080H35	8790-61aa x R980	8891	32.21	31.83	28.7	14.00	0.7	82.8	4.7
R080H34	8790-55aa x R980	8885	36.78	29.93	35.6	14.81	0.3	82.9	4.0
R080H36	8790-71aa x R980	8840	33.14	29.08	33.5	15.14	-0.1	83.4	5.2
R080H32	8790-47aa x R980	7297	43.70	26.05	40.3	14.05	0.8	81.0	5.5
MEAN		9032		31.14		14.48		82.55	4.98
LSD (.05)		2302		6.77		0.76		2.44	0.53
C.V. (%)		14.71		12.85		3.70		2.09	10.71
F value for variety		3.20**		4.68**		2.45**		1.85*	4.34**
F value for virus treatment		545.45**		964.01**		28.35*		8.68NS	
F value for variety x virus		1.05NS		1.10NS		1.90*		1.21NS	

[7] Mean virus yellows scored from 6/18/91, 6/28/91 & 7/18/91. Score from 0 to 9 (100% of matured leaf canopy yellowed.

TEST 1491. NONINOCULATED EVALUATION OF MULTIGERM GERMPLASM, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 26,27.30, 1991
Not BYV Inoculated

Variety	Description[4]	Acre Yield: Sugar[5] lbs	Acre Yield: Sugar[6] lbs	Acre Yield: Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters[2] %
Checks										
SP7622-0	Inc. SP22-0 (L80466)	6921	8922	31.93	13.97	0.0	142	83.8	7.2	11.6
768	Inc. 868 (US 75)	8557	10815	38.58	14.03	0.0	142	82.3	8.4	0.5
U86-37	Inc. C37 (86443)	11000	12556	41.05	15.30	0.5	142	81.2	8.0	0.0
R079	RZM R979 (C37R_z)	10020	12141	40.35	15.06	0.0	145	83.2	7.3	1.9
R028	RZM 9221 (B_1F_2 PI07) (C28)	9967	10604	41.68	12.71	0.0	152	78.9	6.9	8.3
R030	RZM 9225 (F_1R_z x F_1 PI07)	10420	11911	41.90	14.19	0.0	147	80.5	5.5	6.6
U86-46/2	Inc. C46/2 (86342)	10970	13230	43.68	15.14	0.0	149	81.8	6.1	0.0
R078	RZM R978C2 (C46R_z)	11160	13267	42.53	15.61	0.0	147	84.5	7.1	0.0
F86-31/6	Inc. C31/6 (86263)	13910	14775	48.66	15.16	0.0	139	83.1	5.9	0.0
R076	RZM R976 (C31R_z)	12160	13249	46.22	14.29	0.0	148	81.8	6.3	0.5
R080	RZM R980 (C54R_z)	12640	13754	45.89	14.99	0.0	149	83.8	6.8	0.0
Y054	BYR-ER-PMR Y854 (C54)	12390	13434	43.90	15.30	0.0	152	84.1	5.0	0.0
R722	Inc. F_2 (Y54 x B.m.)	9321	10333	36.69	14.08	0.0	143	80.9	7.0	20.9
R022R2	RZM R922R	9881	11583	43.68	13.26	0.0	142	81.1	8.0	12.7
R022Y	Inc. R922Y	11090	11661	42.35	13.73	0.0	142	79.7	6.5	0.5
R004	RZM R904	6336	7754	32.26	11.97	3.0	141	79.6	6.0	41.2
R070	Inc. R971-R980	11590	12474	43.77	14.26	0.0	139	83.1	7.0	0.5
Y048	Inc. Y948 (C93)	11880	13510	41.90	16.12	0.0	145	82.3	6.4	0.0
Y049	BYR-ER-PMR Y849 (C49)	14320	16119	50.77	15.89	0.0	147	83.4	3.5	0.0
Y057	BYR-ER-PMR Y857	12580	14252	48.22	14.75	0.0	145	82.7	6.8	0.0

TEST 1491. NONINOCULATED EVALUATION OF MULTIGERM GERMPLASM, 1991

(continued)

Variety	Description[4]	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters[2] %
R020	RZM R920 (C94)	9643	12436	45.45	13.68	0.4	143	82.5	6.7	1.4
Y039	Inc. Y939 (C39)	12650	14297	45.01	15.87	0.5	134	83.4	4.1	0.6
R039C6	RZM R939C5 (C39R)	13500	15528	51.58	15.05	0.5	142	82.3	4.3	0.0
Y047	Inc. Y947 (C47)	12410	13701	44.25	15.46	0.6	142	84.5	5.5	0.0
R047C6	RZM R947C5 (C47R)	11180	13372	44.70	14.98	0.5	146	83.4	5.9	0.5
0914	RZM R939/4H44	10590	11627	41.46	13.97	0.5	142	81.3	5.1	0.0
R029	RZM 9223(B_1F_2 PI07)	10810	12858	44.92	14.32	0.0	143	81.0	5.5	9.2
R031	RZM 9226 (F_1R_2 x F_1 PI07)	11940	14160	47.79	14.79	0.6	143	83.1	6.6	3.4
0910	RZM 9910H47 (A,aa)	11880	13701	47.89	14.32	0.0	147	83.1	6.8	0.0
0911	RZM 9911 (A,aa)	12540	14278	47.12	15.13	0.0	146	82.1	6.2	0.0
0913	RZM 9911H49 (A,aa)	11200	11832	40.02	14.83	0.0	145	81.7	5.3	0.0
0915	9903aa x 9911H49	12510	14203	47.83	14.83	0.0	140	84.2	5.8	0.0
Mean		11186	12760	43.56	14.59	0.22	144.0	82.3	6.23	3.75
LSD (.05)		1219	1764	5.0	0.98	0.77	8.1	3.2	1.00	3.70
C.V. (%)		11.60	11.23	9.3	4.86	514.78	5.4	2.8	15.88	72.83
F value for variety		15.04**	16.80**	12.7**	20.24**	4.04**	1.7*	3.7**	9.63**	40.71**
F value for virus treatment			5914.4**	1781.3**	11.76*	1.24NS	0.8NS	199.4**	11.04*	8.74*
F value for variety x virus			1.61*	1.5*	2.01**	0.59NS	1.4NS	1.6*	1.01NS	2.52**

[1]BYV inoculated means and % loss are summarized on the following page.

[2]Means over both virus treatments.

[3]PM rated 8/16/91, 8/27/91, & 9/6/91 on a scale of 0 to 9. PM was not controlled in tests 1291 thru 1591 and was quite severe on susceptible varieties.

[4]R022R2 = 2 cycles sel. for resistance to rhizomania from R722. R022Y = 1 cycle selection for BYV resistance. R004 = rhizomania resistant accession.

[5]Variety means over both virus treatments analyzed as RCB (32 x 8 reps).

[6]Variety means for noninoculated treatment.

TEST 1491. BYV INOCULATED EVALUATION OF MULTIGERM GERMPLASM, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 26,27,30, 1991
BYV Inoculated: May 10, 1991

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss[8] %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows[7] Rating
Checks									
SP7622-0	Inc. SP22-0 (L80466)	4920	44.85	19.67	38.24	12.44	1.5	76.9	6.9
768	Inc. 868 (US 75)	6300	41.75	24.95	35.33	12.63	1.4	78.4	5.6
U86-37	Inc. C37 (86443)	9443	24.94	32.59	20.62	14.47	0.8	79.7	3.8
R079	RZM R979 (C37R_z)	7894	34.98	28.09	30.39	14.05	1.0	82.0	5.1
R028	RZM 9221 (B_1F_2 PI07) (C28)	9331	12.00	34.36	17.56	13.57	-0.8	82.2	4.8
R030	RZM 9225 (F_1R_z x F_1 PI07)	8923	25.09	31.53	24.76	14.12	0.1	81.4	4.0
U86-46/2	Inc. C46/2 (86342)	8707	34.19	29.82	31.73	14.53	0.6	82.2	4.8
R078	RZM R978C2 (C46R_z)	9049	31.79	32.04	24.67	14.15	1.5	81.3	5.2
F86-31/6	Inc. C31/6 (86263)	13052	11.66	43.55	10.50	14.94	0.2	82.2	3.3
R076	RZM R976 (C31R_z)	11078	16.39	37.93	17.93	14.60	-0.3	83.0	4.1
R080	RZM R980 (C54R_z)	11525	16.21	38.58	15.94	14.92	0.1	83.0	4.2
Y054	BYR-ER-PMR Y854 (C54)	11355	15.48	37.25	15.15	15.24	0.1	83.2	4.7
R722	Inc. F_2 (Y54 x B.m.)	8309	19.59	31.70	13.59	13.09	1.0	80.2	4.6
R022R2	RZM R922R	8178	29.40	31.04	28.93	13.18	0.1	76.5	5.2
R022Y	Inc. R922Y	10511	9.86	37.47	11.52	14.01	-0.3	81.0	4.7
R004	RZM R904	4917	36.58	23.59	26.88	10.43	1.5	76.7	5.3
R070	Inc. R971-R980	10714	14.12	36.14	17.45	14.80	-0.5	80.6	4.8
Y048	Inc. Y948 (C93)	10252	24.12	32.59	22.22	15.73	0.4	81.0	4.6
Y049	BYR-ER-PMR Y849 (C49)	12515	22.36	40.57	20.09	15.44	0.4	83.8	4.3
Y057	BYR-ER-PMR Y857	10906	23.48	35.03	27.36	15.58	-0.8	82.5	4.4

TEST 1491. BYV INOCULATED EVALUATION OF MULTIGERM GERMPLASM, 1991

(continued)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss[8] %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows[7] Rating
R020	RZM R920 (C94)	6850	44.92	29.73	34.58	11.53	2.1	77.7	6.3
Y039	Inc. Y939 (C39)	11004	23.03	34.47	23.40	15.97	-0.1	83.0	4.2
R039C6	RZM R939C5 (C39R)	11463	26.18	38.29	25.77	14.97	0.1	82.8	4.9
Y047	Inc. Y947 (C47)	11120	18.83	37.69	14.82	14.71	0.8	83.0	4.5
R047C6	RZM R947C5 (C47R)	8996	32.73	30.92	31.05	14.58	0.4	82.2	4.7
0914	RZM R939/4H44	9548	17.87	33.92	18.19	14.10	-0.1	81.1	4.3
R029	RZM 9223(B_1F_2 PI07)	8758	31.89	32.08	28.59	13.65	0.7	79.7	5.1
R031	RZM 9226 (F_1R_2 x F_1 PI07)	9720	31.36	34.19	28.46	14.20	0.6	80.9	5.2
0910	RZM 9910H47 (A,aa)	10066	26.53	35.92	25.00	14.02	0.3	81.1	4.3
0911	RZM 9911 (A,aa)	10804	24.33	36.25	23.08	14.89	0.2	80.5	4.4
0913	RZM 9911H49 (A,aa)	10570	10.66	35.92	10.25	14.73	0.1	82.1	3.9
0915	9903aa x 9911H49	10815	23.85	36.67	23.32	14.71	0.1	81.7	3.9
Mean		9612		33.58		14.19		81.05	4.69
LSD (.05)		1764		5.04		0.98		3.18	0.50
C.V. (%)		11.23		9.31		4.86		2.78	10.69
F value for variety		16.80**		12.68**		20.24**		3.65**	7.69**
F value for virus treatment		5914.38**		1781.28**		11.76*		199.40**	
F value for variety x virus		1.61*		1.54*		2.01**		1.61*	

[7]Mean virus yellows scored from 6/18/91, 6/28/91 & 7/18/91. Score from 0 to 9 (100% of matured leaf canopy yellowed.

[8]% losses calculated from difference between noninoculated and inoculated variety means. Because there were only 4 reps of each variety per treatment, experimental error will be fairly larger. Deviations of 10±% are usual for this type of test.

TEST 1591. NONINOCULATED BYV EVALUATION OF SELECTED LINES, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 26,27,30, 1991
Not BYV Inoculated

Variety	Description[4]	Acre Yield: Sugar[5] lbs	Acre Yield: Sugar[6] lbs	Acre Yield: Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters[2] %
U86-31/6	Inc. C31/6 (86263)	11700	12268	41.04	14.94	0.0	152	85.6	7.0	0.0
Y931	Inc. Y731	11770	12106	43.04	14.03	0.5	145	82.8	6.5	0.0
Y931D	Inc. Y731-HS (Davis)	12440	12129	39.95	15.17	0.0	144	82.6	6.7	0.0
Y931S	Inc. Y731-HS (Salinas)	12350	13369	43.36	15.44	0.0	147	84.5	6.2	0.0
Y931-43	Inc. Y731-43 (C31-43)	13290	13780	44.67	15.43	0.4	144	84.3	7.8	0.0
Y931-89	Inc. Y731-89 (C31-89)	13180	14182	45.72	15.52	0.0	146	82.4	7.6	0.0
Y054-2	Inc. Y854-2	10360	11590	40.76	14.19	0.5	145	83.2	7.1	0.0
Y054-12	Inc. Y854-12	9779	10888	36.58	14.89	0.0	138	85.3	6.5	0.0
Y054-23	Inc. Y854-23	11580	13821	45.59	15.16	0.5	143	83.2	6.4	0.0
Y054-38	Inc. Y854-38	10530	12194	41.25	14.77	0.0	136	81.9	5.9	0.0
Y054-63	Inc. Y854-63	10230	12411	39.08	15.89	0.0	138	83.4	7.8	0.0
Y054-85	Inc. Y854-85	10320	12748	40.68	15.68	0.0	151	84.0	7.8	0.0
Y054	BYR-ER-PMR Y854 (C54)	10490	12686	40.90	15.47	0.0	150	83.8	6.8	0.0
R080	RZM R980	11330	13143	43.41	15.15	0.0	144	83.9	7.2	0.0
R022Y	Inc. R922Y	10890	12252	43.13	14.20	0.0	146	81.6	7.5	0.5
R722	Inc. F_2 (Y54 x B.m.) (C50)	7978	9465	33.66	13.96	0.0	141	82.5	8.1	18.1
0911	9911aa x A	11770	13254	45.41	14.57	0.0	148	83.4	8.8	0.0
0913	9911H49aa x A	11540	13304	44.02	15.00	0.0	143	81.6	6.8	0.0
9911-4	8911-4aa x A	12840	14359	45.12	15.97	0.0	147	82.2	7.2	0.5
9911-12	8911-12aa x A	11710	13651	43.68	15.64	0.0	149	81.4	8.1	0.0
Z010H12	9912aa x Polish(C)	11480	13447	41.90	16.04	0.4	142	82.6	8.5	1.0
Z012H12	9912aa x Polish-2	11520	13973	44.04	15.79	0.0	142	84.7	8.7	0.0
Z014H12	9912aa x Polish-4	12940	16036	47.44	16.88	0.0	144	85.1	7.9	0.0
Z010	Inc. Polish(C)	9254	11036	32.36	17.03	1.0	131	83.4	8.4	0.0

TEST 1591. NONINOCULATED BYV EVALUATION OF SELECTED LINES, 1991

(continued)

Variety	Description[4]	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/100'[2] No.	RJAP %	PM[2,3] Rating	Bolters %
Z011	Inc. Polish-1	8672	10189	28.98	17.56	0.6	136	84.2	8.7	1.5
Z012	Inc. Polish-2	9173	11431	33.79	16.92	0.0	131	84.0	8.3	0.0
Z013	Inc. Polish-3	9398	10979	31.73	17.40	0.5	140	84.1	8.2	0.0
Z014	Inc. Polish-4	9367	11552	31.81	18.11	0.5	129	86.3	7.1	0.0
Z017	Inc. Polish-7	8744	10449	33.25	15.71	1.2	133	84.8	8.0	1.0
Checks										
U86-37	Inc. C37 (86443)	9639	10642	36.41	14.60	0.0	147	81.1	8.5	0.0
768	Inc. 868 (US 75)	8222	10283	38.91	13.28	0.0	140	78.8	8.8	0.0
SP7622-0	Inc. SP22-0 (L80466)	6165	8738	31.75	13.68	0.0	138	83.6	7.7	8.1
Mean		10645	12261	39.80	15.44	0.19	142.2	83.31	7.58	0.96
LSD (.05)		1070	1629	4.90	0.93	0.97	10.6	2.83	0.73	2.30
C.V. (%)		10.90	10.9	9.96	4.35	506.75	6.8	2.43	8.88	239.72
F value for variety		19.58**	19.6**	24.66**	15.52**	0.88NS	2.5**	2.03**	10.04**	17.86**
F value for virus treatment			197.2**	557.78**	19.78*	0.88NS	0.14NS	13.76*	11.82*	0.02NS
F value for variety x virus			3.1**	2.65**	2.03**	1.20NS	0.69NS	1.58*	1.44NS	0.30NS

[1] BYV inoculated means and % loss are summarized on the following page.

[2] Means over both virus treatments.

[3] PM rated 8/16/91, 8/27/91, & 9/6/91 on a scale of 0 to 9. PM was not controlled in tests 1291 thru 1591 and was quite severe on susceptible varieties.

[4] Y931 = YRS C31/6 by mass sel. Y931D & S = Cycle 1 synthetics from HS progeny evaluation under BYV at Davis and Salinas. C31-43 & C31-89 = Increases of HS lines released in 1991. Y054-#'s = Increases of HS progenies selected for performance under BYV. R022Y = BYV sel. from C50. 9911-4 & -12 = HS lines from popn-911 under BYV and LIYV conditions.

[5] Variety means over both virus treatments analyzed as RCB (32 x 8 reps).

[6] Variety means for noninoculated treatment.

TEST 1591. BYV INOCULATED EVALUATION OF SELECTED LINES, 1991

32 entries x 2 virus trtmts x 4 reps, Split-plot
1-row plots, 18 ft. long, 16 blocks

Planted: February 12, 1991
Harvested: September 23-25, 1991
BYV Inoculated: May 10, 1991

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss[8] %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows[7] Rating
U86-31/6	Inc. C31/6 (86263)	11123	9.3	38.58	0.6	14.40	0.5	81.7	3.0
Y931	Inc. Y731	11431	5.6	38.13	11.4	14.96	-0.9	84.1	3.2
Y931D	Inc. Y731-HS (Davis)	12755	- 0.5	41.23	-0.3	15.44	-0.3	83.4	2.9
Y931S	Inc. Y731-HS (Salinas)	11338	15.2	38.35	11.5	14.78	1.0	83.4	2.8
Y931-43	Inc. Y731-43 (C31-43)	12797	7.1	39.91	10.7	16.00	-0.6	83.6	3.8
Y931-89	Inc. Y731-89 (C31-89)	12173	14.2	39.57	13.5	15.38	0.1	82.4	3.3
Y054-2	Inc. Y854-2	9136	21.2	30.82	24.4	14.79	-0.6	84.1	5.2
Y054-12	Inc. Y854-12	8670	20.4	30.37	17.0	14.27	0.6	82.5	5.4
Y054-23	Inc. Y854-23	9341	32.4	32.92	27.8	14.18	1.0	82.8	4.6
Y054-38	Inc. Y854-38	8862	27.3	30.34	26.5	14.60	0.2	82.3	4.3
Y054-63	Inc. Y854-63	8053	35.1	27.71	29.1	14.50	1.3	83.2	4.2
Y054-85	Inc. Y854-85	7893	38.1	26.59	34.6	14.85	0.8	83.0	5.1
Y054	BYR-ER-PMR Y854 (C54)	8304	34.5	27.93	31.7	14.81	0.6	82.9	5.1
R080	RZM R980	9511	27.6	32.04	26.2	14.89	0.3	82.6	4.1
R022Y	Inc. R922Y	9531	22.2	33.59	22.1	14.16	0.0	79.3	3.8
R722	Inc. F_2 (Y54 x B.m.) (C50)	6492	31.4	25.05	25.6	13.06	0.9	78.6	4.8
0911	9911aa x A	10287	22.4	35.47	21.9	14.47	0.1	81.2	4.5
0913	9911H49aa x A	9775	26.5	33.26	24.5	14.72	0.2	82.3	3.9
9911-4	8911-4aa x A	11324	21.1	37.58	16.7	15.03	0.9	80.9	3.4
9911-12	8911-12aa x A	9760	28.5	34.14	21.8	14.31	1.3	83.1	3.3
Z010H12	9912aa x Polish(C)	9504	29.3	30.37	27.5	15.64	0.4	82.7	5.3
Z012H12	9912aa x Polish-2	9069	35.1	29.26	33.6	15.49	0.3	83.4	5.0
Z014H12	9912aa x Polish-4	9848	38.6	30.93	34.8	15.91	0.9	84.4	4.8
Z010	Inc. Polish(C)	7473	32.3	24.95	22.9	15.19	1.9	78.3	5.0

TEST 1591. BYV INOCULATED EVALUATION OF SELECTED LINES, 1991

(continued)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss[8] %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss % Pts	RJAP %	Mean Yellows[7] Rating
Z011	Inc. Polish-1	7155	29.8	21.51	25.8	16.61	1.0	83.3	4.3
Z012	Inc. Polish-2	6915	39.5	21.55	36.2	16.04	0.9	85.0	5.6
Z013	Inc. Polish-3	7818	28.8	23.39	26.3	16.69	0.8	83.3	4.8
Z014	Inc. Polish-4	7182	37.8	21.69	31.8	16.55	1.6	83.2	5.0
Z017	Inc. Polish-7	7039	32.6	22.31	32.9	15.83	-0.1	83.3	6.2
Checks									
U86-37	Inc. C37 (86443)	8637	18.8	30.82	15.3	14.01	0.6	81.1	3.0
768	Inc. 868 (US 75)	6161	40.1	24.57	36.9	12.54	0.7	79.2	5.2
SP7622-0	Inc. SP22-0 (L80466)	3593	58.9	15.08	52.5	11.82	1.8	78.3	6.9
Mean		9030		30.31		14.87		82.29	4.42
LSD (.05)		1629		4.90		0.93		2.83	0.57
C.V. (%)		10.90		9.96		4.35		2.43	13.01
F value for variety		19.58**		24.66**		15.52**		2.03**	12.16**
F value for virus treatment		197.17**		557.78**		19.78*		13.76*	
F value for variety x virus		3.09**		2.65**		2.03**		1.60*	

[7]Mean virus yellows scored from 6/18/91, 6/28/91 & 7/18/91. Score from 0 to 9 (100% of matured leaf canopy yellowed.

[8]% losses calculated from difference between noninoculated and inoculated. Because there were only 4 reps of each variety per treatment, experimental error will be fairly large. Based upon prior experience, a 10+% deviation can be expected. However, for the checks C37, US75, and SP22-0, the measured values of 19, 40, and 59% losses are near expectations.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1990-91

USDA-ARS. Irrigated Desert Research Station

Tests were located in 88 beds on the south side of block J. Rotation previously had not included sugarbeet. All fertilizer was applied preplant as 46:0:0 and 11:52:0 for a total of 155 units of N and 166 units of P_2O_5.

Summary: Arrangement of 1990-91 Tests

Test No.	Entries per Test	No. Reps	Row per Plot[2]	Plot Length (ft)	Harv. Date	Test Design	No. Sugar Samples/ Plot
B191[1]	2	6	2	12.0	1	1	2
B291	32	8	1	24.0	5/22	RCB	1
B391[3]	32	8	1	24.0	5/21	RCB	2
B491[4]	96	4	1	10.5	5/17	RCB[5]	1
B591	32	8	1	24.0	5/16	RCB	1
B691	32	8	1	24.0	5/15	RCB	1

Planted 9/24/90. Watered 9/27 by sprinkler. After emergence, watered by furrow on 10/30, 11/26, 1/3/92, 2/5, 2/26, 3/21, 4/9, and 4/23. Thinned 10/18-19/90. 0.67 pints/acre of Methonyl for fleabeetle control applied 10/11/90.

[1]Split-block with 2 varieties x 4 planting dates x 3 harvest dates. Test in Field N.
[2]Rows 30" wide.
[3]Area 5 Coded Variety Trial.
[4]96 x 4 half-sib progeny test.
[5]Incomplete blocks with 12 entries per set.

Remarks - During mid-winter, petiole nitrates were at normal levels; but for each subsequent sampling date were increasingly higher than commercial average. Tests were uniform and had no cultural problems. LIYV was low, probably less than 10% incidence based upon ELISA from Test B191. BWYV incidence was probably 100%, but infection occurred mid-season to late, when there had been heavy aphid infestations. Powdery mildew was not controlled and was moderate. Very little wet root rot occurred. A surface rot (black scruff) possibly caused by Phoma occurred on some genotypes and caused moderate damage on highly susceptible hybrids. Mites and Empoasca infestations were light up to May 1, 1991 but were moderate by harvest time. Bolting was higher than usual, probably due to a very cold December. Though this block did not have a history of sugarbeet or evidence of rhizomania, breeding materials with rhizomania resistance and/or from the rhizomania resistance breeding program did relatively better than expected. Also, in the near absence of LIYV, some breeding lines performed differently than expected based upon prior testing under LIYV conditions.

Acknowledgement - Clifford Brown, IDRS, for managing these trials.

TEST B191. EFFECTS OF DATE OF PLANTING, VARIETY AND DATE OF HARVEST ON LIYV INCIDENCE AND YIELD IN IMPERIAL VALLEY, 1990-91

8 treatments (4 planting dates x 2 varieties) in RCB x 3 dates in split-block x 6 replications

Treatment	Acre Yield Sugar lbs/a	Acre Yield Beets t/a	% Sucrose	% Bolters	Beets/100 ft No.	Clean Beets %	Nitrate Nitrogen rating	LIYV Inf. %
Varieties								
US H11	6992	24.3	14.4	0.7	153	93.8	4.1	5.0
HH 41	8361	28.0	14.9	0.2	154	94.9	3.7	2.5
Planting Date								
8/30/90	9380	32.3	14.5	0.6	127	93.7	4.0	7.5
9/20/90	8473	28.6	14.8	1.1	162	94.1	3.9	6.9
10/11/90	7563	25.5	14.8	0.0	156	94.6	3.6	0.6
11/01/90	5290	18.3	14.4	0.0	170	95.1	4.0	0.0
Harvest Date								
4/23/91	6605	23.0	14.4	0.0	171	93.5	4.0	---
5/18/91	7704	26.4	14.6	0.6	139	95.2	3.7	---
6/18/91	8721	29.1	15.0	0.7	151	94.5	4.0	---
Grand Mean	7677	26.2	14.6	0.4	154	94.4	3.9	3.75
Varieties	**	**	**	*	NS	**	*	--
LSD(.05) Plant Date	354	1.5	0.6	0.8	14.3	0.5	0.5	--
LSD(.05) Harvest Date	301	1.0	0.2	0.6	10.9	0.5	0.2	--
C.V.(%) V x P x H	9.7	9.4	4.0	329.1	17.4	1.3	14.9	--
F value Varieties	123.4**	49.7**	7.6**	3.2*	0.0NS	32.0**	4.9*	--
F value Plant Date	203.1**	130.3**	1.1NS	4.0*	14.3NS	9.6**	1.2NS	--
F value V x P	7.6**	3.0*	0.4NS	1.4NS	0.1NS	5.6*	0.3NS	--
F value Harvest Date	97.6**	76.1**	16.4**	3.5*	18.4NS	24.1**	5.8*	--
F value V x H	4.6*	3.0*	1.7NS	1.1NS	0.9NS	0.5NS	0.1NS	--
F value P x H	0.7NS	0.8NS	3.4**	1.5NS	0.2NS	2.7NS	1.3NS	--
F value V x P x H	1.3NS	1.3NS	0.5NS	1.0NS	0.8NS	0.9NS	0.1NS	--

Note: LIYV incidence in Imperial Valley in 1990-91 was low. However, pattern of infection was similar to that obtained in 1989-90, Test B190, page A64, 1990 Report. This test was a repeat of the B190 test to determine the effects of variety, planting date, and harvest date on incidence of LIYV and yield. The highest yielding treatment was HH41 planted 8/30/90 and harvested 6/18/91 (11,730 lbs/a). The lowest was US H11 planted 11/1/90 and harvested 4/23/91 (4,070 lbs/a).

TEST B291. PERFORMANCE OF MULTIGERM GERMPLASM, BRAWLEY, CA., 1990-91

32 entries x 8 reps, RCB
1-row plots, 24 ft. long

Planted: September 27, 1990
Harvested: May 22, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot[2] Score	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
Checks									
R080H37	9807HO x R980	10007	35.21	14.21	8.0	4.0	122	95.4	4.4
HH 41	L41138	9889	35.05	14.07	0.0	0.0	140	95.0	5.1
US H11	L786442	7801	29.48	13.23	1.4	0.0	143	91.2	5.0
MM lines									
R070H20	87-309H3 x R971-R980	10147	34.88	14.56	5.0	6.0	130	95.6	4.5
R047C5H20	87-309H3 x R947C5 (C47R)	9831	31.99	15.30	3.4	3.2	130	96.1	4.5
Z012H20	87-309H3 x Polish #2	9802	32.21	15.19	6.8	2.0	143	93.5	4.5
Y039H20	87-309H3 x Y939 (C39)	9608	31.81	15.14	5.7	1.6	147	95.1	4.5
Y846H20	87-309H3 x Y746 (C46/3)	9362	31.67	14.81	0.0	1.6	130	93.9	4.3
Y931SH20	87-309H3 x Y731/S (C31/6)	9219	31.75	14.52	2.9	1.2	133	95.3	4.6
R020H20	87-309H3 x R920 (C94)	9113	33.11	13.81	9.6	1.6	133	95.4	4.9
R039C5H20	87-309H3 x R939C5 (C39R)	8979	31.27	14.35	4.2	1.6	145	93.9	4.8
Y047H20	87-309H3 x Y947 (C47)	8771	30.04	14.59	5.7	3.2	143	93.3	4.4
Z010H20	87-309H3 x Polish #1 to 7	8733	27.46	15.89	2.9	2.4	140	94.5	4.4
Y048H20	87-309H3 x Y948 (C93)	8696	30.02	14.45	3.8	3.2	130	94.0	4.8
Z014H20	87-309H3 x Polish #4	8294	25.76	16.07	4.0	1.6	138	92.7	4.4
HS lines									
Y054-38H20	87-309H3 x Y854-38	9964	31.93	15.63	0.0	1.2	133	94.4	4.8
Y054-23H20	87-309H3 x Y854-23	9814	33.65	14.59	0.3	0.0	130	93.8	4.6
Y054-85H20	87-309H3 x Y854-85	9792	31.90	15.37	0.4	2.0	131	94.3	4.3
R080H20	87-309H3 x R980	9664	32.92	14.65	4.9	3.2	135	94.7	4.8
Y054H20	87-309H3 x BYR Y854	9631	32.09	15.02	0.6	0.0	139	94.6	4.6
Y054-12H20	87-309H3 x Y854-12	9263	31.56	14.63	1.0	1.2	144	95.4	4.6
Y054-63H20	87-309H3 x Y854-63	9176	30.03	15.30	0.9	0.0	137	92.2	4.6
Y054-2H20	87-309H3 x Y854-2	9154	31.11	14.67	2.4	0.0	137	93.8	4.8
Y954H20	87-309H3 x Y854	9094	31.32	14.51	1.6	4.0	94.8	4.5	

TEST B291. PERFORMANCE OF MULTIGERM GERMPLASM, BRAWLEY, CA., 1990-91

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot[2] Score	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
S_1 lines									
0906-4H20	87-309H3 x 8906-4	9854	34.23	14.43	4.8	0.4	136	94.8	4.5
0909-37H20	87-309H3 x 8909-37	9829	33.94	14.48	2.5	0.0	132	94.3	4.4
0909-34H20	87-309H3 x 8909-34	9625	32.32	14.90	9.4	0.0	131	96.1	4.3
0906-7H20	87-309H3 x 8906-7	9536	32.56	14.66	1.8	1.2	134	94.8	4.8
0909-48H20	87-309H3 x 8909-48	9388	32.18	14.60	0.3	0.0	139	95.0	4.3
0909-7H20	87-309H3 x 8909-7	9366	31.08	15.06	8.4	0.4	120	94.0	3.9
9912H20	87-309H3 x RZM 8909-11	9329	33.07	14.15	2.2	1.6	142	95.1	4.6
0913H20	87-309H3 x 9911H49	9031	31.65	14.24	1.7	7.2	138	92.8	4.8
MEAN		9367.6	31.9	14.7	3.3	1.6	135.6	94.4	4.5
LSD (.05)		845.5	2.5	0.8	4.1	1.6	16.7	2.1	0.7
C.V. (%)		9.2	7.8	5.5	125.6	107.8	12.5	2.2	16.2
F value		3.0**	5.1**	4.1**	3.7**	7.6**	1.1NS	2.2**	1.0NS

[1] BYR Y854 = C54 which was mass selected for resistance to BYV. Y854-#'s are from individual HS families selected for per se performance under BYV conditions in 1989. 8906-4 thru 8909-48 are S_1 families from MM, S^f, A:aa popns evaluated per se in 1989. 9807H0 = C306/2CMS. 309H3 = C562H0 x C309. R980 = $Y54R_z$. 9911H49 = MM, S^f, A:aa popn-913. 8909-11 = Composite MM, S^f, A:aa popns-909, 910,911. Polish #1-7 = 2n accessions from Poland.

[2] Root rot score was for a black scruff (Phoma) where 0 = 0% of roots infected to 9 = 90-100% infected.

TEST B591. PERFORMANCE OF MONOGERM GERMPLASM, BRAWLEY, CA., 1990-91

32 entries x 8 replications, RCB
1-row plots, 24 ft. long

Planted: September 27, 1990
Harvested: May 16, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot[2] %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
Checks									
HH 41	L41138	10281	35.19	14.62	1.3	0.5	147	95.4	3.4
US H11	L786442	9499	33.09	14.36	2.0	0.0	144	92.4	3.6
mm lines									
R080H39	89-762-17CMS x R980	11195	38.39	14.55	7.0	1.0	137	94.6	3.5
R080H23	87-309H37 x R980	10771	35.62	15.17	9.7	2.5	133	94.5	2.8
R080H89	88-790-68CMS x R980	10548	33.94	15.57	13.1	2.5	126	94.8	3.1
R080H52	8767-30HO x R980	10393	36.08	14.42	14.0	6.5	128	93.5	3.6
R080H38	89-312CMS x R980	10354	36.84	14.10	4.7	5.5	121	94.2	4.3
R080H40	89-313CMS x R980	10301	35.54	14.49	12.8	5.5	126	94.3	4.3
R080H20	87-309H3 x R980	10093	33.12	15.25	6.0	1.0	134	93.8	3.1
R080H37	9807HO x R980	10021	35.74	14.09	17.2	0.5	118	94.9	3.8
R080H8	F82-546H3 x R980	9875	33.22	14.87	3.5	0.5	131	95.2	3.5
R080H42	C742-24HO x R980	9743	32.50	15.00	7.8	1.5	126	93.6	2.9
R080H26	87-309CMS x R980	9612	31.81	15.12	13.9	7.5	154	93.6	2.8
R080H54	C767-46HO x R980	9311	31.36	14.84	9.4	2.0	126	94.6	3.6
R080H50	8767-20HO x R980	9004	30.37	14.92	36.0	3.0	116	94.6	3.3
mm popns									
R080H113	9867H67aa x R980	11176	36.13	15.46	6.5	1.0	134	94.6	2.8
R080H112	9866H80aa x R980	11112	36.33	15.32	8.3	1.0	138	95.3	2.8
R080H115	9887H86aa x R980	10506	34.48	15.24	7.1	1.5	132	93.8	3.0
R080H111	9859H6aa x R980	10122	33.21	15.34	5.6	0.0	121	94.2	3.0
R080H133	9864aa x R980	9918	34.85	14.23	15.1	0.5	132	95.0	3.9
R080H131	9858aa x R980	9902	33.19	14.95	5.3	1.5	129	95.5	3.3
R080H132	9865aa x R980	9864	33.43	14.85	13.5	1.5	147	94.3	3.3
R080H114	9876H76aa x R980	9553	31.56	15.16	6.8	4.0	128	94.6	3.0

TEST B591. PERFORMANCE OF MONOGERM GERMPLASM, BRAWLEY, CA., 1990-91

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot[2] %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
S_1 lines									
R080H33	8790-54aa x R980	11458	36.57	15.70	8.9	1.0	128	95.3	2.8
R080H30	8790-15aa x R980	11153	36.28	15.35	12.4	0.5	144	94.7	2.9
R080H29	8790-6aa x R980	10974	36.43	15.07	9.8	0.5	134	95.5	2.9
R080H34	8790-55aa x R980	10444	33.34	15.70	11.2	1.5	118	94.8	3.0
R080H90	8790Laa x R980	10181	33.65	15.14	17.5	1.0	136	94.9	2.8
R080H36	8790-71aa x R980	10168	33.61	15.17	15.0	3.5	129	93.5	3.4
R080H32	8790-47aa x R980	9988	32.11	15.61	7.3	3.5	134	94.0	3.0
R080H31	8790-23aa x R980	9730	32.14	15.19	12.9	2.0	137	92.9	3.0
R080H35	8790-61aa x R980	9391	30.91	15.19	9.6	7.5	128	95.3	2.6
MEAN		10207.6	34.1	15.0	10.3	2.3	131.6	94.4	3.2
LSD (.05)		910.5	2.8	0.7	11.0	5.8	18.6	1.5	0.9
C.V. (%)		9.1	8.4	4.8	107.7	263.6	14.3	1.6	27.6
F value		3.5**	3.9**	3.0**	2.6**	1.0NS	1.8*	2.1**	1.9**

1 R980 = $Y54R_z$. 8790L = mm, S^f, A:aa popn-790 (C4 by S_1RS). 8970-#'s = selected S_1 lines from popn-790 (C4) tested per se in 1989 in progeny tests at Salinas (Nov. planted and BYV infected) and Brawley (#'s 54, 15, 55 selected on basis of Imperial Valley performance). This is a different set of lines than any C790-# lines tested or released previously. 309H3 = C562CMS x C309. C309H37 = C306CMS x C309. 9807HO = C306/2CMS. 9858-9887H86 = mm, S^f, A:aa popns being converted to R_z. 9859H6 is similar to C563. 9865 is similar to C309. 9866H80 is similar to C310.

2 Root rot score was for a black scruff (<u>Phoma</u>) where 0 = 0% of roots infected to 9 = 90-100% infected.

TEST B691. PERFORMANCE OF POPULATION HYBRIDS, BRAWLEY, 1990-91

32 entries x 8 replications, RCB
1-row plots, 24 ft. long

Planted: September 27, 1990
Harvested: May 15, 1991

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/100' No.	Clean Beets %	Nitrate Nitrogen Rating
Checks								
HH41	L41138	10484	34.05	15.39	1.4	129	95.2	3.8
US H11	L786442	9290	31.19	14.86	1.5	145	92.4	4.0
mm lines								
0913H39	89-762-17CMS x 9911H49	11623	39.94	14.55	1.3	126	95.2	4.3
Y954H39	C762-17HO x Y854	11356	37.21	15.31	0.0	126	94.5	4.1
0913H40	89-313CMS x 9911H49	10502	35.23	14.90	4.3	129	94.4	4.5
0913H38	89-312CMS x 9911H49	10474	34.76	15.09	1.1	125	95.7	3.9
0913H37	9807HO x 9911H49	10459	35.95	14.57	4.3	127	93.5	4.3
0913H20	87-309H3 x 9911H49	10455	33.55	15.63	0.7	129	95.3	3.4
0913H23	87-309H37 x 9911H49	10242	32.91	15.56	5.6	127	93.8	3.4
0913H8	F82-546H3 x 9911H49	10135	32.52	15.59	0.3	128	94.0	4.0
R070H26	87-309CMS x R971-R980	10105	32.71	15.47	8.4	130	95.6	3.1
0913H26	87-309CMS x 9911H49	10003	32.56	15.36	1.6	125	94.1	3.9
Y954H59	7776-21aa x Y854	9806	31.28	15.69	0.3	125	94.3	3.9
MM x mm tester								
0864H12	9912aa x 9864	10771	35.85	14.94	7.4	137	94.5	3.9
9867H33	6237-14aa x 8852 & 57	10123	33.82	14.96	18.0	129	93.8	4.8
0864H13	9911H49aa x 9864	10105	35.15	14.35	8.4	132	94.5	5.1
0790H12	9912aa x 8790-S_1 (C5)	9845	32.12	15.34	4.7	129	93.9	3.6
mm popns								
0913H113	9867H67aa x 9911H49	10429	34.57	15.09	2.4	129	94.2	4.0
0913H133	9864aa x 9911H49	9746	32.61	14.97	2.9	138	94.9	4.1
0913H112	9866H80aa x 9911H49	9681	32.90	14.72	4.3	133	95.0	4.1
0913H111	9859H6aa x 9911H49	9474	30.78	15.46	2.2	132	93.7	3.8
0913H114	9876H76aa x 9911H49	9409	30.41	15.49	1.7	134	93.4	4.0
0913H115	9887H86aa x 9911H49	9310	31.13	14.93	3.4	135	94.5	4.3

TEST B691. PERFORMANCE OF POPULATION HYBRIDS, BRAWLEY, 1990-91

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
MM lines								
0913H132	9865aa x 9911H49	10593	34.28	15.47	7.9	132	94.5	3.4
Y954H118	8855aa x Y854	10406	33.06	15.70	5.7	139	95.1	3.8
Y039H132	9865aa x Y939 (C39)	10333	32.30	15.99	7.3	130	94.7	4.1
R047C5H132	9865aa x R947C5 (C47R)	10044	31.29	16.07	8.2	133	95.0	3.3
R039C5H132	9865aa x R939C5 (C39R)	9929	32.70	15.20	7.9	119	95.5	4.3
Y047H132	9865aa x Y947 (C47)	9671	31.67	15.26	12.3	141	95.3	3.9
R080H132	9865aa x R980	9641	30.28	15.98	2.7	127	93.9	3.8
Y048H132	9865aa x Y948 (C93)	9217	30.00	15.36	8.5	136	93.3	4.0
R020H132	9865aa R920 (C94)	8906	31.05	14.35	40.4	125	95.6	4.8
MEAN		10080.3	33.1	15.2	5.9	130.7	94.5	4.0
LSD (.05)		874.4	2.7	0.6	5.0	16.3	1.5	1.0
C.V. (%)		8.8	8.2	4.2	86.5	12.7	1.6	24.8
F value		2.1	5.3**	4.1**	17.3**	0.9NS	2.0**	1.6*

[1] 7776-21 = HS line. 546H3 = C562HO x C546. C309H3 = C562HO x C309. C309H37 = C306 x C309. 9807HO = C306/2CMS. 9859H6 - 9987H86 = mm, S^f, A:aa popns being converted to R_z. 9865 & 8855 are similar to C309. Y854 is similar to C54. 9237-14 = FS line from popn-909. 9912 = MM, S^f, A:aa, R_z popn. 9911H49 = MM, S^f, A:aa, R_z popn. 0864H13 and 0913H133 are reciprocal population hybrids made with aa.

TEST B391. CODED VARIETY TRIAL: AREA 5, BRAWLEY, CA, 1991

32 entries X 8 reps, RCB
1-row plots, 27 ft. long

Planted: September 27, 1990
Harvested: May 20, 1991

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100′ No.	Clean Beets %	NO_3-N rating
A5- 6	9BG6372	Beta	11210	40.26	13.90	4.6	0.1	143	93.3	3.8
-16	HM3013	HM	10930	37.03	14.77	9.5	0.0	144	93.3	4.0
-27	H90636	SS	10690	37.16	14.39	12.9	0.8	161	93.7	3.8
-15	HM3014	HM	10580	36.64	14.44	4.9	0.1	150	95.0	3.5
-21	9BG6346	Beta	10520	35.36	14.89	9.7	0.2	151	94.3	3.5
- 4	H90543	SS	10510	35.89	14.66	4.6	1.5	147	96.1	3.7
-22	0BG6486	Beta	10470	39.12	13.39	21.9	0.0	132	94.8	4.3
-20	H90547	SS	10440	35.43	14.74	1.3	0.8	147	95.5	3.6
-11	HH77	HS	10270	37.35	13.75	3.7	0.0	139	92.5	3.9
-19	8BG6329	Beta	10220	32.64	15.67	6.9	0.0	150	92.9	3.6
- 9	HH70	HS	10170	34.55	14.72	7.8	0.2	150	93.9	3.6
-12	87C40-08	HS	10150	36.97	13.74	2.2	0.1	139	93.0	3.5
-23	8BG6332	Beta	10140	32.82	15.46	1.2	0.0	147	93.6	3.6
-26	HH69	HS	10120	34.71	14.57	3.9	0.2	148	93.5	3.7
- 1	HH41	HS	10100	35.56	14.22	2.6	0.0	144	94.4	3.7
- 8	H86519	SS	10060	33.95	14.80	10.0	0.1	138	94.5	3.5
-10	H88589	SS	9968	35.93	13.86	10.0	0.0	147	94.2	4.3
-32	Y047H23	USDA	9960	35.42	14.09	20.9	0.6	139	94.5	3.5
- 5	87C40-011	HS	9927	35.06	14.19	3.9	0.7	138	93.0	3.6
- 3	HM3015	HM	9873	35.55	13.87	5.9	0.2	153	93.7	3.8

TEST B391. CODED VARIETY TRIAL: AREA 5, BRAWLEY, CA, 1991
(continued)

Code	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	Clean Beets	NO_3-N
			Lbs	Tons	%	%	%	No.	%	rating
A5-30	R080H23	USDA	9863	35.24	14.00	12.6	2.2	131	93.6	3.5
-29	H90280	SS	9800	34.42	14.23	16.3	0.1	148	93.6	3.5
-28	HH79	HS	9754	33.20	14.69	1.8	0.5	145	91.7	3.1
-14	H89262	SS	9738	36.87	13.21	9.6	0.1	146	94.6	4.5
-25	0BG6177	Beta	9698	34.04	14.23	6.0	0.3	146	92.4	4.0
-31	Y048H23	USDA	9624	34.11	14.10	16.8	1.0	133	93.8	3.8
- 7	0BG6488	Beta	9624	35.11	13.68	16.5	0.0	148	94.4	4.0
- 2	HH80	HS	9601	33.71	14.26	3.5	1.1	138	91.3	3.5
-17	HH66	HS	9523	32.54	14.65	2.8	0.1	148	93.8	3.8
-18	9BG6270	Beta	9402	29.34	16.02	1.1	0.1	154	91.6	3.4
-13	87C40-012	HS	9123	31.23	14.61	1.2	0.3	137	91.2	3.6
-24	US H11	CBGA	8979	32.92	13.65	1.2	0.1	143	92.3	4.1
Mean			10032	35.00	14.36	7.5	0.4	145	93.6	3.7
LSD (.05)			740	2.48	0.46	4.8	0.4	14.1	1.5	0.5
C.V. (%)			7.5	7.19	3.22	64.5	107	9.9	1.6	14.5
F value			3.4**	6.0**	14.5**	12.2**	12**	1.7*	5.0**	2.3**

TEST B391. CODED VARIETY TRIAL: AREA 5, BRAWLEY, CA, 1991
(continued)

Code	Variety	Source	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Recover. Sugar Lbs/Acre	Recover. Sugar %	Recover. Sugar Lbs/Ton
A5- 6	9BG6372	Beta	470	3131	390	9631	85.6	238
-16	HM3013	HM	427	2772	391	9587	87.6	259
-27	H90636	SS	456	2531	352	9434	88.2	254
-15	HM3014	HM	482	2698	318	9312	87.9	254
-21	9BG6346	Beta	457	2562	342	9315	88.6	263
- 4	H90543	SS	557	2952	453	9033	85.9	252
-22	0BG6486	Beta	583	3032	377	8902	85.1	228
-20	H90547	SS	434	2790	401	9136	87.4	257
-11	HH77	HS	326	2904	415	8896	86.4	237
-19	8BG6329	Beta	399	2613	357	9110	89.1	279
- 9	HH70	HS	472	2512	386	8965	88.1	259
-12	87C40-08	HS	444	3170	479	8597	84.5	232
-23	8BG6332	Beta	402	2741	404	8934	88.1	272
-26	HH69	HS	463	2656	357	8902	87.9	256
- 1	HH41	HS	428	2598	401	8833	87.4	249
- 8	H86519	SS	399	2343	322	9005	89.4	265
-10	H88589	SS	545	2826	452	8550	85.5	237
-32	Y047H23	USDA	487	2763	364	8669	87.0	245
- 5	87C40-011	HS	324	2663	427	8658	87.3	248
- 3	HM3015	HM	526	2928	450	8446	85.3	237
-30	R080H23	USDA	417	2695	386	8616	87.2	244
-29	H90280	SS	447	2983	473	8399	85.7	244
-28	HH79	HS	257	2498	414	8648	88.6	260
-14	H89262	SS	417	2585	328	8521	87.2	231

TEST B391. CODED VARIETY TRIAL: AREA 5, BRAWLEY, CA, 1991
(continued)

Code	Variety	Source	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Recover. Sugar Acre	Recover. Sugar %	Recover. Sugar lbs/Ton
A5-25	0BG6177	Beta	339	2521	330	8612	88.7	252
-31	Y048H23	USDA	478	2931	425	8301	86.0	242
- 7	0BG6488	Beta	593	3190	376	8196	84.8	232
- 2	HH80	HS	398	2894	521	8230	85.6	244
-17	HH66	HS	342	2462	383	8445	88.7	260
-18	9BG6270	Beta	328	2314	438	8427	89.5	287
-13	87C40-012	HS	337	2629	513	7941	86.9	254
-24	US H11	CBGA	432	2831	473	7683	85.5	233
Mean			434	2741	404	8748	87.1	250.5
LSD (.05)			98.3	497	77.7	706	2.4	12.2
C.V. (%)			23.0	18.4	19.6	8.2	2.8	4.9
F value			5.0**	1.6*	3.7**	3.2**	2.7**	10.5**

Notes: Test was harvested wet (3 weeks off water). Test had good stands and was uniform. LIYV infection was low, probably less than 10%. BWYV infection was high. Powdery mildew was mild to moderate. Test had high nitrogen status. No Erwinia root rot or other soft rots were observed. Root rot score was for a black scruff, probably caused by Phoma, which ranged on individual roots from slight to moderate where 0 = 0% of roots infected to 9 = 90-100% of roots infected. Test reliability for gross sugar yield, root yield, and % sucrose is probably good. Reliability for recoverable sugar per acre and per ton is suspect because of high experimental error involved with the measurement of Na, K, and NH_2-N. Codes 30, 31, and 32 are USDA experimental hybrid fillers: 30 = R080H23; 31 = Y048H23; and 32 = Y047H23, where H23 = C306CMS x C309.

RHIZOMANIA TRIALS, SALINAS, CALIFORNIA, 1991

U.S. Agricultural Research Station

A series of three plantings in four field plot areas were made in 1991 to evaluate reaction to rhizomania.

<u>Spence Field Trials</u> - Tests 2291 through 2891 were planted May 8, 1991 in Block 2, north (3 acres) where rhizomania was known to occur. Rhizomania was moderate to severe in these tests. These trials were primarily used to evaluate reaction to rhizomania using yield performance. Powdery mildew was not controlled and became moderately severe. Seedlings showed some evidence of damping-off due to <u>Aphanomyces</u>. Cyst nematodes were moderate in some areas.

<u>Field C and B, Research Station</u> - Tests RZM 191 through RZM 1091 and RZM 3191 through RZM 3491 were planted June 6, 1991. Tests RZM 991 and RZM 1091 were under severe conditions in Field B. Tests RZM 191 through RZM 891 were under moderate conditions. For this area, infested soil was dribbled into the seed line in 1990 and beets grown for about 3 months. In 1991, after listing beds, infested soil was again applied in the seed line prior to planting. The subsequent development of symptoms was only moderate. Tests RZM 191 through RZM 691 and RZM 1091 were to evaluate resistance using yield as the criterion. Tests RZM 791 and RZM 891 were inheritance and allelism tests. Tests RZM 3191 through RZM 3491 were planted in the rows bordering the other yield tests and contained the sprinkler line laterals. Because of higher watering rates, Tests RZM 3191 through RZM 3491 showed somewhat more severe rhizomnia. Powdery mildew was not controlled.

<u>Field A, Research Station</u> - Tests RZM 1191 through RZM 2491 were planted August 6, 1991. These tests were primarily involved in the evaluation and selection of resistance to rhizomania. Tests RZM 2291 through RZM 2491 were also to evaluate and select for resistance to cyst nematode. To obtain one cycle of selection for rhizomania and/or nematode resistance per year, seed obtained from the previous year's mother root selections is planted in late July or early August. After 4 months growth under severe rhizomania conditions, mother roots are selected for resistance based upon visual criteria. After 4 months cold induction and 3-4 months reproductive growth, seed is obtained in mid-July for the next cycle of selection and evaluation. Tests 2291 through 2891 at Spence Field, Tests RZM 191 through RZM 1091, and Tests RZM 3191 through RZM 3491 were used to evaluate breeding materials previously developed in this rhizomania resistance breeding program. In addition, lines and experimental hybrids from the rhizomania program were evaluated in all other trials at Brawley and Salinas.

TEST 2491-1.[1] RHIZOMANIA EVALUATION OF C0 TO C6 SYNTHETICS OF Y39 & Y47
SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: October 29-30, 1991

Variety	Cycle[2]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.
US H11		L 786442	3918	15.82	12.36	209	0.0	82.4	7.2
Rhizosen		Holly L493302	6340	22.10	14.35	213	0.0	84.2	7.3
Rima		SES (3/15/89)	6094	20.24	15.08	192	0.0	82.0	8.4
Y039		Inc. Y939 (C39)	6332	21.26	14.85	163	0.0	83.4	4.6
Y439	C0	Inc. Y339	5764	19.56	14.72	190	0.4	83.6	5.2
R739C3	C3	RZM R639	7405	24.98	14.81	193	0.0	83.8	4.8
R839C4	C4	RZM R739(3)	7310	24.83	14.70	205	0.0	83.2	4.8
R939C5	C5	RZM R839C4	6691	22.78	14.68	205	0.0	82.5	4.1
R039C5	C5	Inc. R939C5 (C39R)	6982	23.75	14.66	170	0.4	83.1	4.4
R039C6	C6	RZM R939C5	7596	25.57	14.84	191	0.8	84.7	4.6
Y547	C0	YR-ER-PMR Y347	5204	18.02	14.55	209	0.0	84.4	4.3
R747	C3	RZM R647	6039	21.45	14.04	203	0.0	82.0	5.4
R847	C4	RZM R747	5833	20.45	14.27	207	0.0	82.5	5.6
R947C5	C5	RZM R847C4	5708	20.12	14.20	202	0.0	82.9	5.6
R047C5	C5	Inc. R947C5 (C47R)	6412	22.34	14.38	184	0.0	83.6	5.8
R047C6	C6	RZM R947C5	6311	22.06	14.24	209	0.0	83.9	6.0
Mean			6246.1	21.58	14.42	196.51	0.10	83.25	5.50
LSD (.05)			829.9	2.87	0.59	20.53	0.53	2.37	1.06
C.V. (%)			13.4	13.4	4.2	10.5	544.3	2.9	19.4
F value			9.4**	6.4**	8.5**	3.9**	1.4NS	1.0NS	10.7**

[1]Test 2491. RHIZOMANIA EVALUATION OF LINES.
64 entries x 8 replications, Incomplete blocks with 4 subtests each with 16 varieties x 8 reps, RCB.
Thus, means across tests 2491-1, -2, -3, -4 can be compared.

	Sugar lbs	Beets tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.
Mean	6353.5	22.52	14.09	189.49	1.42	82.38	5.87
LSD (.05)	946.2	3.37	0.64	20.75	2.06	2.22	0.97
C.V. (%)	15.2	15.2	4.6	11.1	147.6	2.7	16.8
F value	8.2**	6.3**	8.8**	3.3**	59.5**	3.1**	10.0**

[2]Cycle of selection for resistance to rhizomania. Criterion of selection was root shape and size (freedom from visable rhizomania symptoms) when grown under rhizomania conditions in an August 1 to December 1 planting. C0 = source population. Y039, Y439, and Y547 from virus yellows resistance breeding program. See Tests 691 & 1491 for performance under nonrhizomania conditions.

TEST 2491-2. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC LINES, SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: October 29-30, 1991

Variety[1]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.
9903	YR-ER-PMR 7903 (A,aa)	5254	19.31	13.59	194	0.0	82.7	5.2
0911	RZM 9911 (A,aa)	7243	25.19	14.41	166	0.0	83.2	5.3
0911	9911aa x 9911H49	6985	24.99	13.99	187	0.0	81.5	7.1
0913	RZM 9911H49 (A,aa)	6784	23.60	14.37	178	0.0	82.6	5.4
0913	9911H49aa x 9911H49	6629	23.70	13.94	181	0.0	81.9	5.4
0915	9903aa x 9911H49	6961	24.37	14.28	189	0.0	84.1	5.4
U86-37	Inc. C37 (86443)	4676	16.95	13.80	194	0.0	82.0	6.8
R079	RZM R979	5956	20.97	14.20	195	0.0	82.5	6.1
F86-31/6	Inc. C31/6 (86263)	5213	19.32	13.60	196	0.0	82.3	4.4
R076	RZM R976	6556	23.32	14.08	177	0.0	84.3	6.5
U86-46/2	Inc. C46/2 (86342)	5617	20.09	14.03	193	0.0	83.6	5.1
R078	RZM R978C2	6851	23.22	14.77	174	0.0	83.1	6.6
Y954	Inc. Y854 (C54)	5596	19.87	14.07	195	0.0	84.1	5.4
R080	Inc. R980	7597	26.08	14.62	171	0.0	81.8	6.2
R080	RZM R980	7322	25.14	14.58	185	0.0	84.1	6.4
R070	Inc. R971-R980	6950	24.62	14.24	190	0.0	84.2	6.3
Mean		6387.0	22.55	14.16	185.26	0.0	82.98	5.84
LSD (.05)		876.5	3.24	0.53	18.74	---	1.96	0.95
C.V. (%)		13.8	14.5	3.8	10.2	---	2.4	16.5
F value		7.8**	5.6**	3.3**	2.1*	---	1.9*	4.7**

[1]9903 = MM,S^f,A:aa population susceptible to rhizomania. Populations 911, 913, and 915 are backross populations to popn-903 that segregte for resistance to rhizomania. Lines R079, R076, R078, and R080 are the rhizomania resistant, near-isogenic equivalents of C37, C31/6, C46/2, and C54, respectively.

TEST 2491-3. RHIZOMANIA EVALUATION OF LINES DERIVED FROM PI206407 & B883, SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: October 29-30, 1991

Variety[1]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/ 100' No.	Bolters %	RJAP %	P.M. Score Avg.
U86-37	Inc. C37 (86443)	4952	18.07	13.72	211	0.0	82.9	6.1
R079	RZM R979	6444	21.62	14.89	180	0.0	82.5	6.0
R928C1	RZM 8828-#	6448	24.33	13.36	181	3.1	79.5	6.3
R028	RZM 9221	7162	26.41	13.53	185	0.5	82.8	7.1
R030	RZM 9225	7018	24.83	14.11	177	0.0	81.3	5.1
5747	4747aa x A	5471	20.65	13.26	189	0.0	83.9	4.9
0910	RZM 9910H47	6699	24.72	13.55	181	0.0	83.4	6.8
R929C1	RZM 8229-#	6369	23.72	13.49	186	0.4	80.0	5.6
R029	RZM 9223	7711	27.10	14.23	184	0.8	81.4	7.1
R031	RZM 9228	7707	26.12	14.78	172	0.0	82.5	6.8
0913	RZM 9911H49(A,aa)	7835	26.73	14.66	193	0.0	83.0	5.8
N012	NR-RZM 9201,2	6357	23.37	13.61	185	0.0	83.0	7.3
N042	NR-RZM 9205,7,8	6165	22.35	13.81	169	0.0	81.6	7.7
N072	NR-RZM 9210-14	5409	19.92	13.57	177	0.0	81.2	8.0
R004	RZM R904	6670	26.09	12.83	177	1.6	82.2	5.8
Z010H12	9912aa x Polish	7236	23.46	15.40	171	0.0	83.6	6.9
Mean		6603.2	23.72	13.92	182.39	0.39	82.17	6.45
LSD (.05)		842.2	3.14	0.65	15.50	1.26	2.18	0.78
C.V. (%)		12.9	13.4	4.7	8.6	324.0	2.7	12.2
F value		7.9**	5.5**	9.0**	3.3**	3.5**	2.6**	10.3**

[1]R079 = near-isoline of C37 with R_z resistance. R928C1 = F_2(C37 x PI206407) with rhizomania resistance from PI07. R028 = BC_1F_2 of C37 with rhizomania resistance from PI07. R030 = F_2[C37R_z x (C37 x PI07)]. 5747, 0910, R929C1, R029, and R031 are an equivalent series with popn-747 as the rhizomania susceptible base. N012, N042, N072 = rhizomania resistant lines with nematode resistance derived from B883. However, the frequency of NR is very low. R004 = rhizomania resistant accession from Italy with B.maritima characteristics.

TEST 2491-4. RHIZOMANIA EVALUATION OF LINES DERIVED FROM B.MARITIMA, SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: October 29-30, 1991

Variety[1]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.
US H11	L786442	4255	16.62	12.75	213	0.0	83.0	6.9
R039C5	Inc. R939C5 (C39R)	8137	27.73	14.70	165	0.6	82.3	4.8
Y954	Inc. Y854 (C54)	4939	18.24	13.63	191	0.0	82.5	4.4
R080	RZM R980	7542	25.76	14.65	181	0.4	81.7	5.9
R722	Inc. F_2 (Y54 x B.m.)	5554	20.95	13.23	199	4.3	80.0	6.7
R922R1	RZM R722	6422	23.86	13.45	202	4.4	79.7	7.4
R022R2	RZM R922R	7782	29.42	13.32	217	0.0	79.0	7.8
R022Y	Inc. R922Y, S	6563	23.34	14.05	206	0.0	82.4	5.9
R018	RZM R918	5966	22.14	13.47	194	4.3	79.1	5.7
89-C58	Inc. WB1-2 (Whitney)	6629	23.83	13.92	200	2.1	78.7	6.8
EDW-6,7	Composite (WB97 x C37)	3506	13.85	12.62	173	37.9	82.8	2.8
EDW-8,9	Composite (WB242 x C37)	5028	19.97	12.57	174	25.8	80.0	3.7
90-W1	RZM W1-89 (C92 x WB169)	6246	22.52	13.88	200	1.8	80.8	5.5
90-W2	RZM W2-89 (C92 x WB258)	6726	22.59	14.96	204	0.6	81.5	5.9
90-W3	RZM W3-89 (C92 x WB151)	6728	22.24	15.11	201	0.0	81.4	5.4
90-W4	RZM W4-89 (C39 x WB151)	6821	22.48	15.23	181	0.8	82.9	6.0
Mean		6177.6	22.22	13.85	193.78	5.19	81.12	5.72
LSD (.05)		805.1	2.90	0.76	16.78	3.92	2.37	1.10
C.V. (%)		13.2	13.2	5.5	8.7	76.1	2.9	19.3
F value		19.3**	14.1**	10.6**	6.3**	59.4**	3.2**	11.3**

[1] R722 = C50 = Y54 x B.maritima accessions. R022R2 = two cycles of selection for resistance to to rhizomania from R722. R022Y = one cycle of mother root selection for BYV resistance. EDW-6,7 = composite of WB97 crosses obtained from Whitney. EDW-8,9 = composite of WB242 crosses obtained from Whitney. WB97 and WB242 have immunity to common pathovar of powdery mildew. 90-W1 thru 90-W4 are rhizomania resistant lines obtained from Whitney.

TEST 2491-5. OBSERVATION PLOTS OF S^f, mm, A:aa LINES FOR REACTION TO RHIZOMANIA
SALINAS, CA., 1991

16 entries x 2 replications
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: November 4-6, 1991

Variety	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.
0755	BYR-ER-PMR 8755 (C310)	2792	10.64	12.99	167	0.0	79.92	3.5
0866	RZM 9866H80 ($C310R_Z$)	6074	21.81	13.93	142	0.0	80.49	6.5
0787	BYR-ER-PMR 8787	3599	13.30	13.52	164	0.0	87.84	4.8
0887	RZM 9887H86 ($787R_Z$)	6006	21.38	14.00	147	0.0	83.97	6.3
0790	8790-S_1(C)aa x A	3274	12.64	12.94	175	0.0	86.09	4.8
0790H124	9876mmaa x 8790-S_1(C)	4558	16.75	13.58	156	0.0	83.29	7.5
F82-546H3	C562HO x C546	2143	8.07	13.29	128	0.0	83.60	7.0
0859	RZM 9859H6 ($C563R_Z$)	4887	17.00	14.36	142	0.0	81.35	7.3
87-309	Inc. C309	2310	8.43	13.78	175	0.0	81.82	6.8
0865	RZM 9865 ($C309R_Z$)	4496	15.42	14.57	153	0.0	80.26	6.8
0867	RZM 9867H67	6505	22.42	14.51	145	0.0	82.70	6.8
0864	9864aa x A	5167	17.74	14.53	164	0.0	83.26	7.8
0864HO	9867H68 x 9864	6449	21.64	14.90	159	0.0	83.21	8.3
0876	RZM 9876H76	5367	18.58	14.40	170	0.0	84.97	7.0
0914	RZM R939/4H44	6992	25.02	13.98	172	0.0	84.44	3.5
US H11	L786442	3938	14.75	13.34	156	0.0	80.33	7.5
Mean		4659.9	16.60	13.91	157.07	0.0	82.97	6.36
LSD (.05)		1540.0	4.63	1.18	20.50	---	4.52	2.29
C.V. (%)		15.5	13.1	4.0	6.1	---	2.6	16.9
F value		9.1**	11.1**	2.3NS	4.1**	---	2.2NS	3.7**

TEST 2291. RHIZOMANIA EVALUATION OF LINES AND HYBRIDS, SALINAS, CA., 1991

30 entries x 5 replications, RCB
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: November 6, 1991

Variety[1]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	RJAP %	P.M. Score Avg.
Checks									
US H11	L786442	3943	15.57	12.66	169	0.0	0.0	84.0	6.3
Rhizosen	Holly (L493302)	6333	21.89	14.51	156	0.0	0.0	83.0	6.0
Rima	SES	6398	21.70	14.74	159	0.0	0.0	79.8	8.2
Line & Hybrid combinations									
R039C5	Inc. R939C5 (C39R)	6089	21.28	14.27	136	1.5	0.0	82.4	3.8
R039C5H18	88-790-68H26 x R939C5	6354	22.65	14.02	160	0.0	0.0	82.8	5.9
R039C5H132	9865aa x R939C5	7000	24.89	14.12	155	0.0	0.0	81.7	6.4
Y039	Inc. Y939 (C39)	5735	19.76	14.47	138	0.0	0.0	83.6	4.3
Y039H18	88-790-68H26 x Y939	5296	18.82	14.10	167	0.0	0.0	84.1	5.8
Y039H132	9865aa x Y939	5951	20.19	14.74	152	0.0	0.0	83.8	6.3
R047C5	Inc. R947C5 (C47R)	6130	21.81	14.04	162	0.0	0.0	85.4	4.4
R047C5H18	88-790-68H26 x R947C5	5532	20.18	13.71	167	0.0	0.0	83.2	4.6
R047C5H132	9865aa x R947C5	6440	22.62	14.20	167	0.0	0.7	82.0	6.9
Y047	Inc. Y947 (C47)	5027	18.05	13.83	151	0.0	0.0	82.9	3.8
Y047H18	88-790-68H26 x Y947	5055	18.47	13.63	166	0.0	0.0	82.5	4.2
Y047H132	9865aa x Y947	6779	23.13	14.65	165	0.0	0.0	83.8	6.7
R070	Inc. R971-R980	7393	25.89	14.29	157	0.0	0.0	80.8	5.5
R070H18	88-790-68H26 x R971-R980	6650	23.15	14.37	164	0.0	0.0	82.2	6.9
R070H113	9867H67 x R971-R980	7080	25.39	13.96	151	0.0	0.0	83.7	5.3
R080(Sp)	Inc. R980	7082	24.32	14.56	147	0.0	0.0	82.3	5.2
R080H18	88-790-68H26 x R980	6890	23.58	14.59	152	0.0	0.0	81.2	6.8
R080H132	9865aa x R980	6438	21.96	14.70	160	0.0	1.4	81.8	6.7

TEST 2291. RHIZOMANIA EVALUATION OF LINES AND HYBRIDS, SALINAS, CA., 1991

(continued)

Variety[1]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100′ No.	Bolters %	Root Rot %	RJAP %	P.M. Score Avg.
R020	Inc. R920 (C94)	5439	21.12	12.89	154	0.0	0.0	80.4	5.5
R020H18	88-790-68H26 x R920	5325	20.26	13.14	155	0.0	0.8	82.5	6.2
R020H132	9865aa x R920	6557	23.89	13.75	161	0.0	0.0	82.3	7.1
0913	9911H49aa x A	7287	25.78	14.13	146	0.0	0.0	83.4	5.4
0913H18	88-790-68H26 x 9911H49	5835	20.40	14.30	167	0.0	1.3	81.0	6.8
0913H132	9865aa x 9911H49	6985	24.45	14.32	164	0.0	0.0	81.4	7.0
Z010	Inc. Polish acc. 1-7	3244	11.13	14.58	130	0.0	0.0	82.1	5.7
Z010H18	88-790-68H26 x P1-P7	4069	15.38	13.19	151	0.0	0.0	83.7	5.7
Z010H113	9867H67aa x P1-P7	5032	18.06	14.03	158	0.0	0.0	83.0	6.6
Mean		5978.9	21.19	14.08	156.13	0.05	0.14	82.56	5.87
LSD (.05)		983.3	3.25	0.68	17.02	0.79	0.81	3.05	1.16
C.V. (%)		13.1	12.2	3.8	8.7	1224.7	459.3	3.0	15.8
F value		8.6**	8.4**	5.1**	2.6**	1.0NS	1.7*	1.3NS	6.8**

Note: Moderate rhizomania. Moderate powdery mildew infection.

[1]Entries in sets of three where first member is a multigerm line; the second member is a rhizomania susceptible monogerm topcrossed to the MM line; and the third member is a monogerm line that segregates for resistance to rhizomania topcrossed to the MM line.

TEST 2391. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1991

33 entries x 10 reps, RCB
1-row plots, 18 ft. long

Planted: May 7, 1991
Harvested: November 4-5, 1991

Code	Variety[1]	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot[3] %	Beets/100' No.	PM Score[2] Avg	RJAP %
6	90C 64-02	Holly	7340	26.09	14.03	0.0	0.0	130	6.4	83.1
11	90C 59-05	Holly	7202	25.85	13.99	0.0	0.0	137	6.0	82.2
7	H88289	Sprec	7187	24.30	14.82	0.0	0.0	175	6.1	82.6
19	90C 61-03	Holly	7150	23.95	14.88	0.0	0.0	152	6.7	83.4
5	90C 61-06	Holly	7110	24.58	14.49	0.0	0.0	154	5.6	82.5
26	C39R5	USDA	6955	24.27	14.44	0.0	0.0	136	3.8	82.8
24	H88293	Sprec	6907	23.63	14.67	0.0	0.4	160	5.9	82.8
18	SS-334R	Sprec	6851	23.43	14.62	0.0	0.0	138	7.2	83.3
8	90C 63-03	Holly	6832	22.80	14.97	0.0	0.0	152	7.0	83.5
23	90-1459-0168	Holly	6760	23.49	14.37	0.0	0.7	155	6.8	83.1
2	90C 60-05	Holly	6743	24.38	13.85	0.0	0.0	131	6.2	82.0
31	90U-03	Holly	6712	24.54	13.67	0.0	0.0	163	5.7	82.6
22	90U-05	Holly	6659	24.92	13.39	0.0	0.0	154	5.6	82.6
13	H88292	Sprec	6650	23.37	14.25	0.0	0.0	152	6.3	82.4
14	90-1459-0154	Holly	6636	22.73	14.65	0.0	0.0	154	7.3	83.8
29	4581	Beta	6503	22.79	14.26	0.0	0.0	164	5.0	83.2
17	90C 64-03	Holly	6481	22.94	14.15	0.0	0.0	138	5.9	82.5
12	90C 64-05	Holly	6452	22.79	14.15	0.0	0.0	140	6.6	81.1
3	90-87C34-04	Holly	6417	22.58	14.17	0.0	0.5	146	6.9	83.5
4	Rima	USDA	6241	20.88	14.94	0.0	0.0	163	8.3	81.7
15	Rhizosen	USDA	6178	21.62	14.26	0.0	0.0	158	7.1	83.9
16	90-87C34-09	Holly	6145	22.14	13.92	0.0	0.0	155	7.2	81.5
1	90-1459-0161	Holly	6053	21.31	14.19	0.0	0.6	162	6.1	84.2
33	H88287	Sprec	6044	21.09	14.33	0.0	0.0	174	6.7	83.1

TEST 2391. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1991

(continued)

Code	Variety[1]	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot[3] %	Beets/100' No.	PM Score[2] Avg	RJAP %
32	90C 59-03	Holly	5912	21.45	13.81	0.0	0.0	139	5.4	83.3
21	90-88C11-09	Holly	5757	20.43	14.13	0.0	0.3	156	6.7	82.8
28	SS-462R	Sprec	5651	19.92	14.18	0.0	0.0	159	7.4	82.2
25	90-87C34-06	Holly	5588	20.72	13.53	0.0	1.0	158	5.8	82.7
9	90C 63-016	Holly	5524	19.60	14.10	0.0	0.4	159	6.8	83.2
20	90-88C11-02	Holly	5481	20.68	13.28	0.0	0.0	162	6.1	84.1
27	90C 62-05	Holly	5041	18.56	13.67	0.0	0.3	162	6.2	82.9
10	90-88C11-05	Holly	4971	18.67	13.33	0.0	0.4	152	6.3	82.3
30	US H11	USDA	3973	15.59	12.76	0.0	0.0	159	5.7	82.9
MEAN			6306.22	22.31	14.13		0.14	152.97	6.31	82.84
LSD (.05)			794.00	2.81	0.39		0.60	13.01	0.87	1.54
C.V. (%)			14.30	14.29	3.17		484.94	9.66	15.64	2.12
F value			6.94**	5.08**	13.11**		1.49*	5.76**	7.01**	1.68*

[1]Checks were US H11 (susceptible), C39R5 (moderately resistant), and Rima (moderately resistant).

[2]PM was scored on a scale of 0 to 9 where 9 = 90-100% of leaf area covered. PM was scored on 9/10/91 and 9/23/91. No PM chemical control was used. Disease development was late but reached a high level, then after 10/1/91 decreased in severity to nearly nil at harvest. Highly susceptible varieties, such as Rima, probably had differential loss due to PM.

[3]Root rot was primarily due to Erwinia.

Note: Test was moderately uniform and moderately severe for rhizomania. Although differential yield performance was probably partially due to differences in yield potential and adaptation, observations within this test and from adjacent USDA tests suggested that the most important factor was level and uniformity of resistance to rhizomania.

TEST RZM 191. RHIZOMANIA EVALUATION OF LINES DERIVED FROM FORT COLLINS GERMPLASM, SALINAS, CA., 1991

16 entries x 4 replications, RCB
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: November 25, 1991

Variety[1]	Cycle[2]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
US H11	--	L786442	2047	12.10	8.42	200	0.0	73.1	7.3	1.7
R039C5	C5	Inc. R939C5 (C39R)	4846	20.51	11.81	169	0.0	74.7	4.6	4.1
R047C5	C5	Inc. R947C5 (C47R)	4613	19.08	11.93	216	0.8	73.4	6.1	5.9
R080	--	RZM R980 ($C54R_z$)	4118	17.18	11.98	206	0.0	71.8	6.9	4.2
R720	C2	RZM 6220-#'s	3417	18.80	9.06	198	0.0	67.2	6.6	6.3
R820	C3	RZM R720	3949	20.14	9.74	213	0.0	69.5	6.1	5.8
R920	C4	RZM R820 (C94)	3741	19.59	9.52	216	0.0	67.5	6.4	5.9
R020	C4	Inc. R920 (C94)	3381	17.07	9.82	211	1.5	70.5	6.8	7.6
R020	C5	RZM R920	4119	21.41	9.59	233	0.0	68.2	6.6	3.4
911019	C4	1 Rhizoc. R920	3774	18.81	10.08	213	0.0	67.1	6.6	7.1
911020	C3	2 Rhizoc. R820	3640	18.81	9.72	219	0.0	66.8	6.3	7.1
911021	C2	2 Rhizoc. R720	3599	16.69	10.78	225	0.0	67.4	5.3	4.8
891041	C2	1 Rhizoc. R720	3512	17.20	10.28	206	0.0	71.6	6.4	7.8
901008	C3	1 Rhizoc. R820	4190	19.92	10.61	228	0.0	70.1	6.9	5.0
R020H18	--	C790-68H26 x R920	3845	17.06	11.38	188	0.0	70.3	7.8	7.3
R020H132	--	9865aa x R920	3826	16.41	11.85	219	0.0	70.7	8.1	9.7
Mean			3789	18.17	10.41	210	0.1	70.0	6.5	5.9
LSD (.05)			892	3.32	1.52	25	0.8	5.2	1.0	4.1
C.V. (%)			16.5	12.8	10.3	8.5	403.4	5.2	10.6	49.4
F value			3.9**	3.6**	4.3**	3.2**	2.0*	1.8NS	5.8**	1.9NS

Note: Rhizomania was mild-moderate. This plot area did not have rhizomania. In August 1990, infested soil was placed in the seed line and US H11 sown. After 3 months, the sugarbeets were killed with Roundup. Prior to planting in 1991, the seed line was again infested with rhizomania soil. Powdery mildew (PM) was not controlled and became severe on susceptible entries.

[1] R720 thru R020 were cycles 2 thru 5 selected for resistance to rhizomania from a base of Fort Collins and old GW lines (FC703, FC705, FC709, GW674, GW359). 911019 thru 911021 were reselections at Fort Collins by Dr. Hecker for resistance to rhizoctonia. See Fort Collins BSDF for rhizoctonia ratings.

[2] Cycle of selection for resistance to rhizomania.

TEST RZM 291. RHIZOMANIA EVALUATION OF LINES DERIVED FROM B.MARITIMA, SALINAS, CA., 1991

8 entries x 8 replications, RCB
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested:

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
US H11	L786442	1939	11.52	8.47	221	0.0	70.2	6.6	6.60
R039C5	Inc. R939C5	5118	20.88	12.22	191	2.5	73.7	4.5	5.16
Y954	Inc. Y854	3792	15.12	12.55	211	0.0	75.1	4.1	9.07
R080 (Iso)	RZM R980	4788	17.94	13.35	222	0.0	78.5	5.9	6.69
R722	Inc. F_2 (Y54 x B.m.)	2986	13.32	11.23	220	4.2	71.1	5.9	13.17
R022R	RZM R922R	4045	18.61	10.85	214	0.3	71.4	6.4	14.07
R022Y	Inc. R922Y,S	3523	14.76	12.01	216	0.0	72.8	5.8	12.18
89-C58	Inc. WB1-2	2666	11.33	11.62	196	2.1	70.4	5.3	31.12
Mean		3607.0	15.44	11.54	211.43	1.15	72.90	5.57	12.26
LSD (.05)		527.7	2.01	0.80	27.89	1.73	3.88	0.79	8.18
C.V. (%)		14.6	13.0	6.9	13.1	150.2	5.3	14.2	66.4
F value		33.0**	23.7**	26.8**	1.4NS	7.0**	4.3**	9.7**	8.4**

TEST RZM 391. RHIZOMANIA EVALUATION OF C0-C6 SYNTHETICS OF Y39 & Y47, SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: November 26, 1991

Variety	Cycle[1]	Description	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
US H11		L786442	1783	9.47	9.56	222	0.0	71.4	7.2	7.50
Rhizosen		Holly L493302	4784	18.39	13.00	265	0.0	77.1	7.2	4.40
Rima		SES (3/15/89)	4304	16.80	12.77	253	0.0	74.2	8.1	6.99
Y039		Inc. Y939 (C39)	4075	15.27	13.35	189	0.0	78.2	3.5	10.22
Y439	C0	Inc. Y339	4024	14.43	13.99	217	0.0	76.9	4.4	9.35
R739C3	C3	RZM R639	4995	19.01	13.13	228	0.3	75.5	4.9	8.76
R839C4	C4	RZM R739(3)	5412	21.18	12.75	230	0.0	74.4	4.1	6.59
R939C5	C5	RZM R839C4 (C39R)	5442	21.25	12.74	243	0.6	74.6	4.1	6.32
R039C5	C5	Inc. R939C5 (C39R)	6047	24.10	12.61	202	0.0	74.6	4.2	6.29
R039C6	C6	RZM R939C5	6018	23.39	12.84	237	0.4	75.9	4.1	5.99
Y547	C0	YRS Y347	3587	13.36	13.40	209	0.0	77.2	5.3	5.42
R747	C3	RZM R647	4747	18.52	12.86	244	0.0	76.5	6.1	3.52
R847	C4	RZM R747	4904	18.36	13.37	256	0.0	78.2	6.7	5.45
R947C5	C5	RZM R847C4 (C47R)	4559	17.13	13.27	266	0.0	77.7	6.4	4.84
R047C5	C5	Inc. R947C5 (C47R)	5190	19.42	13.33	232	0.0	77.1	6.4	5.17
R047C6	C6	RZM R947C5	5401	21.05	12.77	256	0.0	76.1	6.7	3.52
Mean			4704.5	18.20	12.86	234.3	0.08	75.97	5.58	6.27
LSD (.05)			721.2	2.56	0.79	22.5	0.44	2.80	0.73	3.71
C.V. (%)			15.5	14.2	6.2	9.7	562.5	3.7	13.2	59.6
F value			16.4**	17.3**	11.3**	8.0**	1.3NS	3.2**	29.8**	2.2*

Note: Rhizomania was mild to moderate.

[1]Cycle of selection for resistance to rhizomania. Criterion of resistance based upon visual assessment of freedom from root symptoms, root size, and root shape. One cycle per year was made. Seed planted in late July into field soil with severe rhizomania. Harvested and selected in late November or early December. Roots induced in cold room. Seed production from March to July. Y39 and Y47 appear to have quantitative (additive) type resistance.

TEST RZM 491. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC LINES, SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: November 25, 1991

Variety[1]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
86-37	Inc. C37 (86443)	2480	9.38	13.30	230	0.0	74.1	7.9	11.86
R079	RZM R979	4154	14.99	13.85	239	0.0	75.3	6.8	8.69
86-46/2	Inc. C46/2 (86342)	3866	14.21	13.65	245	0.0	77.0	4.8	12.15
R078	RZM R978C2	5157	18.62	13.89	228	0.0	76.3	6.6	9.08
F86-31/6	Inc. C31/6 (86263)	4719	17.06	13.81	229	0.0	77.6	4.3	5.76
R076	RZM R976	5727	21.54	13.26	234	0.0	76.9	6.4	8.57
Y954	Inc. Y854 (C56)	4480	15.54	14.43	237	0.0	79.1	4.9	7.65
R080	RZM R980	5276	19.04	13.90	234	0.0	76.7	7.1	9.09
R080	Inc. R980	5650	19.86	14.20	224	0.0	76.8	6.3	8.37
R070	Inc. R971-R980	5127	19.74	12.98	253	0.0	75.7	6.9	9.04
R039C6	RZM R939C5 (C39R)	6238	23.45	13.29	257	0.3	75.4	4.9	6.69
R020	RZM R920 (C94)	4991	25.24	9.86	252	0.3	69.6	7.0	7.97
9903	YR-ER-PMR 7903	4006	14.76	13.58	252	0.0	77.2	5.4	14.36
0911	RZM 9911 (A,aa)	4590	17.39	13.22	245	0.0	74.6	6.1	11.37
0913	RZM 9911H49 (A,aa)	5123	18.36	13.94	240	0.0	75.8	6.6	11.03
0915	9903aa x 9911H49A	4564	17.03	13.39	241	0.0	75.5	6.1	8.34
Mean		4759.4	17.89	13.41	239.94	0.03	75.85	6.13	9.38
LSD (.05)		636.4	2.22	0.66	21.35	0.27	1.90	0.69	4.07
C.V. (%)		13.5	12.5	5.0	9.0	804.6	2.5	11.4	43.8
F value		15.2**	23.3**	19.0**	1.7NS	0.9NS	9.3**	16.0**	2.3**

Note: Rhizomania was mild to moderate.

[1]Near-isogenic lines where disease resistant base lines C37, C46/2, C31/6, C54, and popn-903 were used as recurrent parents and selected for R_z source of resistance. Pairs are: C37 & R079; C46/2 & R078; C31/6 & R076; C54 & R080; and popn-903 & 0915. 0911 & 0913 are intermediate backcross popns. R070 is a root composite of C37, C31, C46, & C54 types.

TEST RZM 591. RHIZOMANIA EVALUATION OF LINES DERIVED FROM PI206407 and B883, SALINAS, CA., 1991

16 entries x 8 replications, RCB
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: December 2, 1991

Variety[1]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
86-37	Inc. C37 (86443)	2662	10.06	13.27	234	0.0	72.4	7.1	7.42
R079	RZM R979	4050	14.30	14.13	255	0.0	74.7	6.6	6.19
R928C1	RZM 8828-#	3324	14.82	11.20	214	1.5	72.2	5.4	16.93
R028	RZM 9221	3423	13.74	12.38	246	0.3	71.2	7.1	12.75
R030	RZM 9225	4742	18.75	12.67	229	0.0	74.3	5.4	9.72
5747	4747aa x A	3154	13.20	11.78	213	0.0	72.3	6.5	6.05
0910	RZM 9910H47	4739	19.16	12.40	231	0.0	73.0	7.4	7.84
R929	RZM 8229-#	3901	15.83	12.35	212	0.4	73.2	5.9	13.91
R029	RZM 9223	4516	18.20	12.38	235	0.3	71.1	6.7	11.52
R031	RZM 9228	5241	19.95	13.07	222	0.0	74.3	7.1	6.01
0913	RZM 9911H49	4983	17.81	14.00	242	0.0	72.9	5.8	9.18
N012	NR-RZM 9201,2	5031	21.21	11.88	253	0.0	72.6	7.6	4.23
N042	NR-RZM 9205,7,8	4896	19.92	12.31	261	0.0	74.0	8.0	5.00
N072	NR-RZM 9210-14	5255	21.18	12.49	241	0.0	71.6	7.9	5.93
R004	RZM R904	4195	21.08	9.88	238	1.3	72.5	5.3	13.25
Z010H12	9912aa x Polish(C)	4696	16.71	14.02	242	0.0	76.2	7.3	7.60
Mean		4300.6	17.25	12.51	235.45	0.24	73.03	6.68	8.97
LSD (.05)		600.4	2.25	0.84	26.48	1.20	2.90	0.87	3.96
C.V. (%)		14.1	13.2	6.8	11.3	499.5	4.0	13.1	44.5
F value		14.1**	17.1**	13.2**	2.5**	1.3NS	1.8*	8.2**	6.9**

Note: Rhizomania was mild to moderate.

[1]PI206407 is a Turkish accession; one plant with chard-like traits was highly resistant to rhizomania and crossed to C37 and popn-747. R928C1 = F_2(C37 x PI07). R028 = BC_1F_2(C37*2xPI07). R030 = F_2(R_zr_z x PI07). R079 = C37R_z. 0910 = 747R_z. R929 = F_2(747aa x PI07). R029 = BC_1F_2(747*2xPI07). R031 = F_2(R_zr_z x PI07). 0913 = 903R_z. N012, N042, N072 = BC_1F_2 (lines x B883); these N#'s have very low frequency of resistance to cyst nematode because of low transmission of resistance. These N# lines' performance is in part due to the non-nematode resistance background of B883. R004 = accession from Italy with wild beet traits and high resistance to rhizomania. Z010H12 = F_1(R_z x high sugar Polish accessions).

TEST RZM 3191. EVALUATION OF MONOGERM S^f,A:aa,R_z POPULATIONS, SALINAS, CA., 1991

16 entries x 2 replications
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: December 2, 1991

Variety	Description[1]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/100'	Bolters	RJAP	P.M. Score	Soil Tare
		Lbs	Tons	%	No.	%	%	Avg.	%
0755 (C310)	BYV-ER-PMR 8755	1580	5.58	14.18	269	0.0	80.2	5.5	17.32
0866	RZM 9866H80	4010	12.20	16.42	247	0.0	79.9	7.3	8.56
0787	BYR-ER-PMR 8787	2110	8.56	12.27	219	0.0	78.9	6.0	3.08
0887	RZM 9887H86	4253	15.18	13.98	213	0.0	79.0	7.3	24.08
0790	8790-S_1(C)aa x A	3055	12.07	12.74	216	0.0	78.9	6.3	8.51
0790H124	9876mmaa x 8790-S_1(C)	3815	14.53	13.24	206	0.0	79.5	7.0	9.03
F82-546H3	C562HO x C546	1748	7.66	11.63	244	0.0	75.1	7.3	6.37
0859	RZM 9859H6,9858	2380	8.95	13.34	234	0.0	74.5	8.5	10.35
87-309	Inc. C309	1731	6.36	13.41	234	0.0	74.1	8.3	7.74
0865	RZM 9865	3984	12.85	15.69	234	0.0	75.9	8.8	11.17
0867	RZM 9867H67	4329	15.57	13.97	225	0.0	76.8	6.3	8.35
0864	9864aa x A	3682	12.59	14.57	219	0.0	82.5	7.3	10.19
0864HO	9867H68 x 9864	4398	15.18	14.44	209	0.0	75.5	7.3	11.09
0876	RZM 9876H76	3268	11.03	14.76	197	0.0	75.3	7.0	14.58
0914	RZM R939/4H44	4337	15.18	14.06	250	0.0	74.3	4.0	7.89
US H11	L786442	2212	8.56	12.99	197	0.0	75.4	6.8	25.44
Mean		3180.8	11.38	13.86	225.78	0.0	77.23	6.91	11.49
LSD (.05)		1203.0	3.52	1.89	37.05	---	5.21	2.00	22.46
C.V. (%)		17.7	14.5	6.4	7.7	---	3.2	13.6	91.8
F value		7.0**	8.3**	3.8**	2.7*	---	2.3NS	3.1*	0.7NS

Note: Rhizomania was mild to moderate.

[1]Near-isogenic pairs are 0755(C310) & 0866; 0787 & 0887; 0790 & 0790H124; 546H3 & 0859; C309 & 0865. 0800 #'s segregate for R_z & monogerm. 0914 = MM,S^f,A:aa version of C39R.

TEST RZM 3291. OBSERVATION OF POLISH LINES AND HYBRIDS, SALINAS, CA., 1991

16 entries x 2 replications
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: December 2, 1991

Variety[1]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
Z010	Inc. Polish (C)	3639	11.16	16.37	200	0.0	79.0	7.0	8.26
Z010H8	F82-546H3 x Polish (C)	3233	11.33	14.20	191	0.0	81.8	7.0	2.56
Z010H12	9912aa x Polish (C)	4704	14.92	15.41	216	0.0	77.7	8.5	6.96
Z010H111	9859H6aa x Polish (C)	3673	14.54	12.61	225	0.0	78.3	8.3	3.68
Z012	Inc. Polish-2	3277	10.38	15.86	184	0.0	78.9	8.5	2.78
Z012H12	9912aa x Polish-2	3837	13.23	14.49	188	0.0	76.3	8.0	8.82
Z012H20	87-309H3 x Polish-2	3859	14.27	13.61	259	0.0	74.2	8.0	7.20
Z012H111	9859H6aa x Polish-2	4168	14.92	13.95	213	0.0	77.2	8.0	6.05
Z014	Inc. Polish-4	2783	8.48	16.33	156	0.0	83.7	7.5	11.98
Z014H12	9912aa x Polish-4	4932	16.09	15.34	194	0.0	77.7	7.0	7.29
Z014H20	87-309H3 x Polish-4	2952	9.47	15.55	206	0.0	78.7	8.3	6.92
Z014H111	9859H6aa x Polish-4	3451	11.94	14.47	181	0.0	77.6	7.8	4.35
Z011	Inc. Polish-1	3946	11.68	16.85	181	0.0	83.4	8.0	1.92
Z013	Inc. Polish-3	3500	10.12	17.28	213	0.0	80.9	6.8	6.35
Z017	Inc. Polish-7	4149	13.46	15.49	181	0.0	81.2	6.5	4.17
US H11	L786442	2114	8.95	11.74	209	0.0	76.5	7.5	4.05
Mean		3638.6	12.18	14.97	199.8	0.0	78.94	7.66	5.83
LSD (.05)		1241.0	3.68	1.73	65.6	---	3.61	1.29	6.77
C.V. (%)		16.0	14.2	5.4	15.4	---	2.1	7.9	54.5
F value		2.9*	3.8**	6.9**	1.2NS	---	4.8**	2.2NS	1.4NS

Note: Rhizomania mild to moderate.

[1] Z010 = composite of seven Polish accessions. Hybrids with H8 & H20 are susceptible to rhizomania. Hybrids with H12 & H111 codes segregate for R_z.

TEST RZM 3391. THIRD PROGENY SET, SALINAS, CA., 1991

16 entries x 2 replications
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: December 2, 1991

Variety[1]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
0911- 4	8911aa x A	6469	20.11	16.08	216	0.0	77.9	6.5	24.48
9911-12	8911aa x A	5489	17.60	15.60	216	0.0	77.6	6.5	16.48
9911-14	8911aa x A	6556	20.24	16.19	259	0.0	79.3	5.0	17.18
9911-50	8911aa x A	6798	21.67	15.68	203	0.0	81.3	5.8	8.41
9912- 3	RZM 8909,9,10,11aa x A	6274	20.89	15.02	219	0.0	78.5	6.3	10.59
9912-11	RZM 8909,9,10,11aa x A	5375	17.78	15.10	209	0.0	79.9	7.3	10.23
9911H49- 5	7903aa x 8911	5538	17.65	15.69	225	0.0	80.9	6.5	10.71
9911H49-18	7903aa x 8911	5708	18.13	15.69	188	0.0	77.5	7.0	18.29
9911H49-22	7903aa x 8911	5362	17.00	15.83	150	0.0	80.0	3.3	8.47
9911H49-25	7903aa x 8911	4900	15.96	15.39	188	0.0	80.1	5.3	14.77
Checks									
US H11	L786442	1788	6.88	12.92	269	0.0	75.8	7.0	19.04
0911	9911aa x A	5217	17.21	15.16	234	0.0	78.7	7.5	17.08
0913	9911H49aa x A	5477	18.42	14.90	231	0.0	75.8	6.0	12.73
0915	9903aa x 9911H49	4826	16.09	14.99	200	0.0	79.1	7.0	15.28
HH41	L412305	2455	9.34	13.16	234	0.0	77.9	5.8	9.67
Rhizosen	L493302	5495	18.04	15.31	256	0.0	79.7	7.3	11.23
Mean		5232.8	17.06	15.17	218.56	0.0	78.74	6.23	14.04
LSD (.05)		1623.0	5.31	1.49	49.21	---	3.57	1.88	10.33
C.V. (%)		14.6	14.6	4.6	10.6	---	2.1	14.1	34.5
F value		6.3**	4.9**	3.5*	3.4*	---	1.9NS	3.0*	1.8NS

[1] Half-sib (HS) families from popns-911,-912,-913. Popns-911,-912,-913 are MM,S^f,A:aa,R_z populations in a popn-747 to popn-903 background. Half-sib families were produced in 1989. Progeny tests were run in 1990 at Brawley (LIYV) and Salinas (Bolting, BYV, PM, & Rhizomania). Based upon these progeny tests, 10 lines were selected and increased in isolators from stecklings in 1991. TX's of these families will be performance tested in 1992. Seed is from original HS productions.

TEST RZM 3491. EVALUATION OF S_1 PROGENY FAMILIES FROM MM,S^f,A:aa,R_z POPULATIONS, SALINAS, CA.,1991

16 entries x 2 replications
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: December 2, 1991

Variety[1]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
First Progeny Set (S_1's): TX hybrids tested in 1990 in tests 590, 2290, B790. Lines 9907-14, 9908-7, and 9909-13 were selected for R_z in 1990 and mother roots are being increased in isolators in 1991.									
9907-14	Inc. 7907-14-#	4522	15.70	14.39	244	0.0	79.4	6.3	6.36
9907-21	Inc. 7907-21-#	3344	12.72	13.11	172	0.0	78.2	8.5	10.61
9908- 2	Inc. 8908- 2-#	2557	9.73	13.09	203	0.0	72.9	6.3	8.21
9908- 7	Inc. 7908- 7-#	4783	17.78	13.46	219	0.0	75.8	7.5	7.92
9909-13	Inc. 8909-13-#	2921	10.64	13.73	206	0.0	77.6	8.0	25.26
9909-14	Inc. 8909-14-#	2271	8.56	13.29	181	0.0	75.2	7.8	7.50
9909-16	Inc. 8909-16-#	2570	8.95	14.35	272	0.0	72.5	6.8	10.23
Second Progeny Set (S_1's): TX hybrids being evaluated in 1991 tests at Brawley and Salinas. Progeny tests were run in 1989. Selections were increased in isolators in 1990.									
0906- 4	Inc. 8906A- 4	4176	14.53	14.38	238	0.0	75.5	8.3	7.18
0906- 7	Inc. 8906A- 7	3774	12.85	14.68	222	0.0	74.9	8.5	6.24
0909- 7	Inc. 8909A- 7	3997	13.36	14.95	222	0.0	77.7	7.5	17.61
0909-34	Inc. 8909A-34	4970	17.97	13.87	238	0.0	76.8	6.3	6.21
0909-37	Inc. 8909A-37	4183	15.31	13.69	225	0.0	78.5	5.5	12.60
0909-48	Inc. 8909A-48	3150	10.64	14.78	156	0.0	76.2	7.8	5.17
Checks									
8909	Composite aa x A	4482	15.96	14.04	228	0.0	75.5	7.3	6.52
0911	9911aa x A	5050	18.23	13.90	197	0.0	76.6	7.0	8.70
US H11	L786442	1576	6.86	11.48	197	0.0	74.6	6.3	11.76
Mean		3645.3	13.11	13.83	213.67	0.0	76.11	7.20	9.88
LSD (.05)		840.9	3.06	0.91	39.65	---	4.65	2.15	11.63
C.V. (%)		10.8	11.0	3.1	8.7	---	2.9	14.0	55.2
F value		14.2**	12.5**	8.0**	4.9**	---	1.5NS	1.7NS	1.8NS

TEST RZM 691. SCREEN OF HYBRIDS UNDER MILD RHIZOMANIA, SALINAS, CA., 1991

12 entries x 5 replications, RCB
1-row plots, 16 ft. long

Planted: June 5, 1991
Harvested: November 21, 1991

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	RJAP %	P.M. Score Avg.	Soil Tare %
Rhizosen	Holly L493302	4880	19.88	12.27	245	0.0	73.0	7.8	3.25
Rima	SES (3/15/89)	4728	18.53	12.73	248	0.0	73.6	7.8	8.60
US H11	L786442	2482	12.92	9.51	244	0.0	70.0	7.3	4.80
R080H133	9864aa x R980	5428	20.97	12.94	268	0.0	73.2	7.4	6.75
R039C5	Inc. R939C5	5273	21.59	12.23	226	0.0	69.9	4.9	6.54
Z012H12	9912aa x Polish-2	5241	18.48	14.18	249	0.0	75.7	7.3	6.59
R039C5H113	9867H67aa x R939C5	5076	20.14	12.62	243	0.0	72.4	6.3	9.24
OJ7081		5567	19.31	14.48	259	0.0	77.2	7.8	3.88
OJ7062		4993	19.62	12.74	254	0.0	72.3	7.1	5.35
OJ0157		4831	18.37	13.11	279	0.0	73.7	6.3	6.73
OJ5019		4273	17.54	12.19	236	0.0	73.8	8.6	4.43
OJ0175		4168	17.39	12.01	245	0.0	72.0	7.3	7.87
Mean		4744.8	18.73	12.58	249.48	0.0	73.07	7.16	6.17
LSD (.05)		799.0	2.82	1.06	36.23	---	3.65	0.94	4.06
C.V. (%)		13.2	11.8	6.6	11.4	---	3.9	10.3	51.6
F value		8.7**	5.1**	11.0**	1.2NS	---	2.6*	8.3**	1.7NS

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1991

150 entries x 3 replications

Test Conducted by Terry Brown, BSDF

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
CHECKS			
US 33	Check	4.7*	5.5*
US 41	Check	4.1*	4.5*
HYBRIDS			
US H11	L786442	4.0	4.7
Rhizosen	Holly	5.7	6.3
WS-PM9	Hilleshog-MH	3.7	4.0
Vyxen	Hilleshog	5.0	6.0
6625	Betaseed	5.7	6.7
SS-NB3	Spreckels	4.0	4.7
Y954H20	(C562HO x C309) x C54	4.0	4.7
R080H20	(C562HO x C309) x R980	4.3	5.0
Y846H20	(C562HO x C309) x C46/3	4.7	5.0
Y931SH20	(C562HO x C309) x C31/6	4.3	5.0
R020H20	(C562HO x C309) x C94	4.7	5.0
R039C5H20	(C562HO x C309) x C39R5	4.3	4.3
Y039H20	(C562HO x C309) x C39	4.3	5.0
R047C5H20	(C562HO x C309) x C47R5	4.7	5.0
Y047H20	(C562HO x C309) x C47	4.3	4.7
R070H20	(C562HO x C309) x R971-80	4.3	4.7
Y048H20	(C562HO x C309) x C93)	4.0	5.0
Z010H20	(C562HO x C309) x Polish C	4.7	5.7
Z012H20	(C562HO x C309) x Polish 2	4.3	5.3
Z014H20	(C562HO x C309) x Polish 4	4.3	5.3
0913H20	(C562HO x C309) x 9911H49	4.0	4.7

Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
HYBRIDS			
0913H132	popn-865aa x 9911H49	4.7	5.3
0913H133	popn-864aa x 9911H49	4.3	5.0
0864H13	popn-911H49aa x popn-864	4.3	4.7
US H11	(C562HO x C546) x C36	4.0	4.7
R080H8	(C562HO x C546) x R980	4.0	5.3
R080H18	(C309CMS x C790-68) x R980	5.0	5.0
R080H23	(C306CMS x C309) x R980	4.7	5.3
R080H26	C309CMS X R980	4.7	5.7
R080H37	C306/2CMS x R980	4.7	5.0
R080H38	C312CMS x R980	4.7	5.3
R080H39	C762-17CMS x R980	4.3	5.0
R080H40	C313CMS x R980	5.0	5.3
R080H42	C742-24CMS x R980	5.0	5.3
R080H54	C767-46CMS x R980	5.0	5.7
R080H70	C766-62CMS x R980	4.7	5.3
R080H72	C718HO x R980	4.3	5.0
R080H89	C790-68CMS x R980	5.0	5.0
R080H67	popn-767aa x R980	4.7	5.3
R080H76	popn-776aa x R980	4.3	5.3
R080H90	C790aa x R980	4.0	5.3
R080H111	popn-859H6aa x R980	4.0	5.3
R080H112	popn-866H80aa x R980	4.0	5.0
R080H113	popn-867H67aa x R980	4.3	5.0

[1]Mean of 3 replications.

* = average of 21 to 23 times repeated in test.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1991

(continued)

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
HYBRIDS			
R080H114	popn-876H76aa x R980	5.0	5.0
R080H115	popn-887H86aa x R980	4.0	5.0
R080H121	popn859mmaa X R980	4.7	5.3
R080H122	popn-866mmaa x R980	4.0	5.0
R080H123	popn-867mmaa x R980	4.3	5.3
R080H124	popn-876mmaa x R980	4.7	5.3
R080H125	popn-887mmaa x R980	4.7	5.0
R080H131	popn-858aa x R980	4.3	5.0
R080H132	popn-865aa x R980	4.3	5.0
R080H133	popn-864aa x R980	4.3	5.7
MM, OPEN-POLLINATED			
768	Inc. 868 (US 75)	4.3	5.0
86-37	Inc. C37 (86443)	4.3	4.7
R079	RZM R979 ($C37R_z$)	4.3	4.7
R028	RZM (C37*2 x PI07)	4.3	4.7
9101	Inc. C11T	6.3	7.3
9102	Inc. C12T	7.0	7.7
86-46/2	Inc. C46/2 (86342)	4.7	5.0
R078	RZM R978C2 ($C46R_z$)	5.0	5.3
86-31/6	Inc. C31/6 (86263)	5.3	6.0
Y931-43	Inc. Y731-43	6.3	6.3
Y931-89	Inc. Y731-89	5.3	6.0
R076	RZM R976 ($C31R_z$)	5.3	6.3
N012	NR-RZM 9201,2	4.3	5.3
R070	Inc. R971-R980	4.7	5.7
R080	RZM R980 ($C54R_z$)	5.0	6.0
R080	Inc. R980 ($C54R_z$)	5.7	6.3
Y054	BYR-ER-PMR Y854 (C54)	5.3	6.0
Y054- 2	Inc. Y854- 2	5.3	5.7
Y054-12	Inc. Y854-12	5.7	6.3
Y054-23	Inc. Y854-23	5.3	6.0
Y054-38	Inc. Y854-38	5.0	5.7

Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
MM, OPEN-POLLINATED			
Y054-63	Inc. Y854-63	4.7	5.0
Y054-85	Inc. Y854-85	4.7	5.0
Y048	Inc. Y948 (C93)	5.0	5.3
Y049	BYR-ER-PMR Y849 (C49)	5.3	5.0
Y057	BYR-ER-PMR Y857	4.7	5.3
R020	RZM R920 (C94)	5.7	6.7
Y039	Inc. Y939 (C39)	5.3	6.0
R039C6	RZM R939C5 (C39R5)	4.3	5.3
Y047	Inc. Y947 (C47)	4.7	5.7
R047C6	RZM R947C5 (C47R5)	5.3	6.7
89-C58	Inc. C58 (EDW)	5.3	6.0
R022R	RZM R922R (C50)	5.3	6.0
R022Y	Inc. R922Y,S	4.3	5.3
Z010	Inc. 2n Polish C	6.3	7.7
Z011	Inc. 2n Polish-1	7.0	8.0
Z012	Inc. 2n Polish-2	5.7	6.0
Z013	Inc. 2n Polish-3	6.7	7.0
Z014	Inc. 2n Polish-4	6.0	7.3
Z017	Inc. 2n Polish-7	5.7	7.0
Z010H12	9912aa x Polish C	5.0	6.0
Z012H12	9912aa x Polish-2	5.0	6.0
Z014H12	9912aa x Polish-4	5.3	6.0
MM, s^f, A:aa POPULATIONS & LINES			
5747	popn-747aa x A	4.7	4.7
N042	NR-RZM 9205,7,8	5.0	5.7
R029	popn-747aa*2 x PI07	4.7	5.0
0910	RZM 9910H47 ($747R_z$)	4.3	4.3
0911	RZM 9911	4.3	4.7
0911	9911aa x 9911H49	4.0	4.7
0913	RZM 9911H49	4.7	5.3
0913	9911H49aa x 9911H49	4.7	5.0
0915	9903aa x 9911H49	4.7	5.0

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1991

(continued)

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
MM,S^f,A:aa POPULATIONS & LINES			
9903	YR-ER-PMR popn-903	4.7	5.0
0906-4	Inc. 8906A-4	5.7	6.7
0906-7	Inc. 8906A-7	5.7	6.3
0909-7	Inc. 8909A-7	5.7	5.7
0909-34	Inc. 8909A-34	5.3	5.0
0909-37	Inc. 8909A-37	5.7	6.0
0909-48	Inc. 8909A-48	5.0	5.7
0914	RZM R939/4H44	4.3	5.0
mm,S^f,A:aa POPULATIONS			
0755	BYR-ER-PMR 8755 (C310)	5.0	5.3
0866	RZM 9866H80 (C310R_z)	4.7	5.0
9855	RZM 8855	4.7	5.3
0865	RZM 9865 (C309R_z)	5.0	5.7
0859	RZM 9859H6 (C563R_z)	4.0	4.7
0864	9864aa x A (ppn-767R_z)	4.3	5.0
0867	RZM 9867H67 (popn-767R_z)	4.0	5.0
0876	RZM 9876H76 (popn-776R_z)	4.3	5.0
0887	RZM 9887H86 (popn-787R_z)	4.0	4.7
0787	BYR-ER-PMR 8787 (popn-787)	4.0	4.7
0790	8790-S_1 (C)aa x A (C790)	4.0	4.3
N072	NR-RZM[1]9210-14	5.3	5.7

Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
mm,S^f LINES			
0722	Inc. T-O 9722-#	5.7	7.3
F82-546H3	C562HO x C546 (82460)	4.3	4.7
9554H1	NB1CMS x NB 4	4.3	5.0
87-309H3	C562HO x C309 (87671)	4.3	4.7
87-309H37	C306CMS x C309 (87242)	4.7	5.7
87-309	Inc. C309 (87672)	5.3	6.0
F82-562	Inc. C562 (82196)	4.3	4.7
88-790-68	Inc. C790-68	5.3	6.3
0762-17	Inc. C762-17	4.0	4.3
0766-23	Inc. C766-23	5.3	6.3
0766-62	Inc. C766-62	5.0	5.0
0767-46	Inc. C767-46	4.3	5.7
0796-43	Inc. C796-43	4.3	5.0
0833	Inc. ST-O 9833-#	4.3	5.0
0790- 6	8790A- 6	5.0	6.0
0790-15	8790A-15	5.3	6.0
0790-23	8790A-23	5.0	5.3
0790-47	8790A-47	4.7	4.7
0790-54	8790A-54	4.7	5.3
0790-55	8790A-55	5.0	5.3
0790-61	8790A-61	4.3	4.7
0790-71	8790A-71	4.3	5.0
0852- 7	Inc. 9852- 7	5.3	6.7
0852-52	Inc. 9852-52	5.3	6.3

TEST 2091. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION OF LINES, SALINAS, CA., 1991

160 entries x 3 replications
1-row plots, 18 ft. long

Planted: April 16, 1991
E.c.b. Inoculated: July 11, 1991
Scored: September 25,26,27,30, 1991
October 1, 1991

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	Erwinia Reaction[2] % Resistant	P.M. Avg.[3]
MM, O.P. lines						
E840 (C40)	Inc. E440, E640	25	6.9	84.7	7.8	7.9
768	Inc. 868 (US 75)	23	1.6	29.0	45.8	7.0
U86-37	C37, 86443	25	1.3	17.3	65.0	7.6
R979	Inc. R879	24	0.0	3.2	85.8	6.2
R079	RZM R979	26	1.2	9.0	79.1	6.2
R928C1	RZM (C37 x PI07)	23	0.0	9.2	76.3	5.2
R028	RZM 9221 (C28)	23	4.2	22.5	62.8	6.6
R030	RZM 9225	25	1.3	17.0	68.5	5.5
Y854	Inc. Y654	23	4.0	5.7	85.7	5.4
Y954	Inc. Y854	22	0.0	4.6	85.0	4.8
R980	RZM 8244-#'s	23	0.0	9.6	87.2	5.4
R080	Inc. R980	23	0.0	13.3	71.7	5.6
R080	RZM R980	25	0.0	17.7	69.5	5.5
Y054 (C54)	BYR-ER-PMR Y854(C54)	24	0.0	2.1	92.9	3.5
Y054-2	Inc. Y854-2	24	1.3	3.2	94.0	3.9
Y054-12	Inc. Y854-12	24	1.4	1.8	94.6	4.9
US H11	L786442	27	0.0	11.9	79.9	7.3
Y054-23	Inc. Y854-23	24	0.0	0.3	97.2	5.4
Y054-38	Inc. Y854-38	24	1.6	3.6	91.6	3.8
Y054-63	Inc. Y854-63	24	2.8	13.5	70.5	5.5
Y054-85	Inc. Y854-85	23	3.3	26.6	64.6	5.7
Y54 x B.maritima						
R722 (C50)	Inc. F_2(SBxB.m.)	24	4.3	20.0	69.2	6.3
R922R1	RZM R722	25	2.8	37.4	45.3	6.6
R022R2	RZM R922R	25	0.0	37.4	45.7	7.0
R022Y	Inc. R922Y	25	0.0	23.5	67.9	5.8
MM. O.P. lines						
R970	RZM R871-R879, 8244	25	1.4	14.6	72.5	5.8
R070	Inc. R971-R980	25	3.9	13.0	81.6	5.6
86-46/2	C46/2, 86342	26	0.0	6.6	86.8	4.5
Y846	Inc. Y746 (C46/2)	25	2.7	9.7	78.3	3.7
R978C2	RZM R878	22	1.6	16.9	67.5	4.6
R078	RZM R978C2	23	2.9	19.7	69.9	5.3
N012	NR-RZM 9201,2	25	4.0	12.1	82.8	6.3

TEST 2091. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION OF LINES, SALINAS, CA., 1991

(cont.)

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	% Resistant	P.M. Avg.[3]
F86-31/6	86263, Inc. C31/6	23	3.0	18.4	66.6	5.4
Y931	Inc. Y731	24	0.0	15.3	65.4	4.8
R976	RZM R876	24	5.5	18.6	70.2	5.3
R076	RZM R976	22	3.1	22.8	65.9	5.6
E840	Inc. E440, E640	25	0.0	94.9	2.8	7.8
Y931-43	Inc.Y731-43 (C31-43)	26	0.0	1.7	92.3	5.6
Y931-89	Inc.Y731-89 (C31-89)	26	0.0	5.5	81.9	5.1
F86-91	Inc. C91, 86019	26	0.0	1.7	94.8	3.8
Y941	YR-ER-PMR Y741	25	1.3	5.7	89.1	3.7
Y048	Inc. Y948 (C93)	25	0.0	4.2	87.0	4.3
Y949	Inc. Y849 (C49)	23	0.0	6.1	85.7	3.7
Y049	BYR-ER-PMR Y849	26	0.0	2.1	90.9	3.7
Y057	BYR-ER-PMR Y857	26	0.0	0.7	93.8	6.5
Y939 (C39)	YR-ER-PMR Y739	27	0.0	2.5	95.1	3.9
Y039	Inc. Y939 (C39)	23	0.0	3.4	90.0	3.3
R939C5	RZM R839C4 (C39R)	25	1.3	24.6	61.3	4.3
R039C5	Inc. R939C5 (C39R)	22	1.6	22.6	65.8	4.4
R039C6	RZM R939C5	24	0.0	25.2	60.5	3.8
Y947 (C47)	YR-ER-PMR Y747	26	1.2	4.8	83.2	4.1
Y047	Inc. Y947 (C47)	23	1.5	5.2	80.0	4.1
US H11	L786442	27	0.0	5.5	80.5	7.3
R047C5	Inc. R947C5 (C47R)	25	0.0	9.5	77.2	6.2
R047C6	RZM R947C5	26	0.0	7.5	85.8	6.8
R903	RZM R803 (Alba gp)	26	0.0	49.9	35.9	6.8
R904	RZM ROVIGO Acc.	25	1.4	20.6	58.2	4.8
R004	RZM R904	22	7.9	22.9	54.9	5.8
R920	RZM R820 (C94)	27	0.0	47.5	42.5	6.3
R020	Inc. R920 (C94)	27	0.0	47.4	38.4	5.8
R020	RZM R920	23	1.6	54.6	36.9	6.5
9101	Inc. 8101 (C11T)	22	0.0	5.3	81.9	4.1
9102	Inc. 8102 (C12T)	22	0.0	10.8	73.2	4.1
Z010	Inc. Polish 1-7	22	0.0	26.4	54.8	6.8
Z010H12	9912aa x P#(C)	25	0.0	9.5	76.6	6.3
Z010H111	9859H6aa x P#(C)	24	0.0	25.0	61.0	6.8
Z011	Inc. Polish #1	21	0.0	25.8	57.2	6.8
Z012	Inc. Polish #2	23	1.4	27.6	61.8	6.4

TEST 2091. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION OF LINES, SALINAS, CA., 1991

(cont.)

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	Erwinia Reaction[2] % Resistant	P.M. Avg.[3]
Z012H12	9912aa x P_2	23	0.0	16.9	69.6	6.8
Z012H111	9859H6aa x P_2	24	0.0	19.0	67.4	7.1
Z013	Inc. Polish #3	24	0.0	8.4	82.1	7.0
Z014	Inc. Polish #4	22	0.0	42.4	46.5	6.0
E840	Inc. E440, E640	27	1.3	90.7	3.8	8.0
Z014H12	9912aa x P4	23	1.6	14.8	67.5	6.5
Z014H111	9859H6aa x P4	25	0.0	28.3	52.2	6.8
Z017	Inc. Polish #7	23	0.0	8.1	79.1	5.8
MM, S^f, A:aa lines and populations						
5747	4747aa x A	26	1.2	2.4	88.4	6.1
9910	8910aa x A	22	0.0	11.8	74.7	5.5
9910H47	5747aa x 8910	24	0.0	12.4	72.6	6.1
0910	RZM 9910H47 (A,aa)	25	1.4	12.3	75.7	6.3
R929C1	RZM 8229-#	25	2.5	4.6	86.4	4.0
R029	RZM 9223	24	1.3	14.2	70.0	5.0
R031	RZM 9226	24	1.3	13.2	78.3	6.4
N042	NR-RZM 9205,7,8	22	0.0	17.0	59.8	7.4
7903	6903aa x A	21	1.6	3.4	89.4	4.6
9903	YR-ER-PMR 7903 (A,aa)	24	0.0	6.6	78.0	4.3
8909	7909,7239aa x A	24	0.0	13.4	73.8	4.8
9911	RZM 7239	25	0.0	11.1	65.9	4.8
US H11	L786442	26	2.6	5.1	78.6	7.6
9911H49	7903aa x 8911(C)	24	1.5	14.9	73.8	5.3
0911	9911aa x A	25	2.8	19.6	64.1	6.4
0911	RZM 9911 (A,aa)	24	0.0	13.2	73.5	5.2
0913	RZM 9911H49 (A,aa)	22	0.0	10.6	80.5	4.8
0913	9911H49aa x A	23	0.0	7.8	71.9	5.0
0915	9903aa x 9911H49	21	3.3	7.5	78.6	4.8
0906-4	Inc. 8906-A-4	26	1.4	25.8	60.8	7.2
0906-7	Inc. 8906A-7	25	0.0	19.0	64.6	7.8
0909-7	Inc. 8909A-7	24	1.4	10.8	79.1	5.2
0909-34	Inc. 8909A-34	24	1.5	3.5	89.7	3.5
0909-37	Inc. 8909A-37	24	0.0	6.9	85.6	3.3
0909-48	Inc. 8909A-48	21	1.4	17.7	68.0	5.6
0914	RZM R939/4H44	24	0.0	10.9	80.9	3.8

TEST 2091. ERWINIA ROOT ROT AND POWDERY MILDEW EVALUATION AND OBSERVATION OF LINES, SALINAS, CA., 1991

(cont.)

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	Erwinia Reaction[2] % Resistant	P.M. Avg.[3]
Monogerm, S^f, A:aa populations						
8790 (C790)	7790aa x A (C4,Syn 2)	25	0.0	33.4	44.8	5.8
0790	8790-S_1(C)aa x A	26	0.0	35.0	36.6	5.9
0790H124	9876mmaa x 8790-S_1(C)	23	0.0	40.0	36.5	6.1
8776	NB 6776 (A,aa)	24	0.0	9.7	75.1	6.3
0876	RZM 9876H76	24	1.3	16.9	68.5	6.6
8787	7755-7797aa x A	25	0.0	17.9	59.4	6.8
E840	Inc. E440, E640	24	0.0	88.3	5.6	7.6
0787	BYR-ER-PMR 8787	23	0.0	14.8	66.7	5.3
0887	RZM 9887H86	25	1.4	33.8	46.8	6.3
9858	Inc. RZM 8858	26	0.0	29.4	53.3	6.9
9859H6	1566aa x 8850,1,4,8	24	0.0	28.4	41.9	6.5
0859	RZM 9859H6	25	0.0	36.3	38.3	6.8
N072	NR-RZM 9210-14	23	0.0	22.9	63.3	7.3
8767	NB 6767 (A,aa)	26	0.0	28.8	58.3	5.1
9864	RZM 8247-#	23	0.0	35.8	46.7	6.0
0864	9864aa x A	25	0.0	39.3	39.5	6.1
9867H67	8767aa x 8852,8857	23	0.0	27.1	57.4	6.3
0867	RZM 9867H67	25	1.3	40.4	40.2	6.4
8755	7755,6aa x A	26	0.0	21.6	59.9	6.0
0755	BYR-ER-PMR 8755	27	0.0	15.7	67.2	5.2
9866H80	8755aa x 8853,5,6	25	0.0	21.5	59.7	5.9
0866	RZM 9866H80	28	0.0	25.0	58.1	6.5
US H11	L786442	26	1.4	6.2	78.8	7.6
9855	RZM 8855	24	0.0	33.3	53.4	6.2
9865	RZM 8246-#	26	0.0	24.4	65.4	7.0
0865	RZM 9865	26	0.0	37.2	44.7	7.2
Monogerm, S^f lines						
0722	Inc. T-O 9722-#	23	0.0	8.5	80.7	4.6
F82-546H3	78155, C562HO x C546	23	0.0	8.0	71.8	6.3
87-309H37	87242, C306 x C309	24	0.0	27.6	40.3	7.8
87-309H3	87671, C562 x C309	25	0.0	14.8	54.1	7.9
88-790-68H26	C309CMS x C790-68	25	0.0	26.9	41.3	8.2
88-790-68H92	C796-22CMS x C790-68	26	0.0	16.4	56.4	6.2
88-790-68H37	C306CMS x C790-68	23	0.0	49.0	16.8	5.1
F82-546	82372, C546	23	0.0	2.7	89.6	6.3

TEST 2091. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION OF LINES, SALINAS, CA., 1991

(cont.)

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	Erwinia Reaction[2] % Resistant	P.M. Avg.[3]
F82-562	82196, C562	23	0.0	34.0	46.0	6.8
F82-562HO	82196, C562HO	24	0.0	28.6	44.4	6.7
87-309	87672	23	0.0	24.4	44.2	7.9
87-309CMS	87670	26	0.0	22.7	39.4	8.1
88-790-68	C790-68	20	0.0	31.0	41.0	5.3
88-790-68CMS	C790-68CMS	24	0.0	47.5	35.4	5.4
89-762-17	89121, C762-17	21	0.0	61.7	24.8	5.0
E840	Inc. E440, E640	27	0.0	92.0	3.7	8.0
0762-17	Inc. 89-762-17	22	1.5	50.1	37.8	5.1
89-312	89482, C312	19	0.0	19.9	67.9	3.3
89-313CMS	C313CMS, L89439	22	0.0	65.5	19.1	3.5
9807	T-O 8807-# (C306)	23	0.0	45.6	34.7	4.5
9833	T-O 8833-#	25	0.0	31.7	52.3	6.0
0833	Inc. T-O 9833-#	26	0.0	34.7	39.2	7.8
0766-23	9766-23 (C766-23)	26	0.0	19.2	63.6	5.3
0766-62	9766-62 (C766-62)	25	0.0	10.0	83.8	6.3
0767-20	Inc. 8767-20	25	0.0	2.8	94.5	5.4
0767-30	Inc. 8767-30	23	0.0	4.5	85.7	5.8
9767-46	5767-46 (C767-46)	27	0.0	5.5	81.6	5.5
0767-46	Inc. T-O 9767-46-#	25	0.0	0.3	95.8	5.8
0796-43	5796-43 (C796-43)	25	0.0	8.5	68.5	5.8
0852-7	Inc. 9852-7	23	0.0	22.2	64.1	5.7
0852-52	Inc. 9852-52	16	0.0	29.5	63.3	5.2
US H11	L786442	26	1.3	7.7	72.4	7.0
Mean		24	0.76	20.87	64.95	5.77
LSD (.05)		3.6	2.97	13.67	19.59	1.06
C.V. (%)		9.3	243.2	40.9	18.9	11.5
F value		1.8**	1.6**	13.9**	8.6**	9.9**

[1]% plants infected with downey mildew on 6/17/91. Counts difficult to make and highly variable.

[2]Erwinia root rot: DI = average % rot per root at harvest; % resistant = percent of roots scored 0 and 1% rot.

[3]Powdery mildew not controlled. Scored on scale of 0 to 9 where 9 = 90-100% of mature leaf area covered by visable mildew. PM scored 8/14,8/21,and 8/28/91.

TEST 2091B. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION OF LINES & HYBRIDS, SALINAS, CA., 1991

32 entries x 1 replication
1-row plots, 18 ft. long

Planted: April 16, 1991
E.c.b. Inoculated: July 11, 1991
Scored: October 3, 1991

Variety[1]	Description	Roots No.	Downey Mildew %	Erwinia Reaction DI	Erwinia Reaction % Resistant	P.M. Avg.
E840	Inc. E440, E640	28	0.0	92.6	3.6	7.8
US H11	L786442	24	0.0	2.9	70.8	6.5
87-309	Inc. C309 (87672)	25	0.0	19.2	56.0	7.3
88-790-68	Inc. C790-68	23	0.0	46.3	34.8	4.3
F82-546	Inc. C546 (82372)	21	0.0	11.7	61.9	4.8
F82-562	Inc. C562 (82196)	23	0.0	38.9	34.8	5.3
0790-6	8790-6 (C790-6)	17	0.0	47.3	23.5	4.5
0790-15	8790-15 (C790-15)	22	0.0	31.8	27.3	1.0
0790-23	8790-23	17	0.0	25.9	35.3	4.0
0790-47	8790-47	22	0.0	38.7	45.5	4.3
0790-54	8790-54 (C790-54)	13	0.0	9.2	84.6	3.8
0790-55	8790-55	19	0.0	44.4	31.6	4.3
0790-61	8790-61	24	0.0	59.4	16.7	3.8
0790-71	8790-71	18	0.0	44.8	38.9	3.8
0790A	Inc. 8790-S_1(C)	25	0.0	42.6	40.0	4.8
0790	8790-S_1(C)aa x A	27	0.0	39.1	48.1	5.0
US H11	L786442	26	0.0	4.0	73.1	7.3
E840	Inc. E440, E640	24	0.0	90.3	4.2	6.5
R080H26	87-309CMS x R980	25	0.0	28.7	52.0	7.3
R080H89	88-790-68CMS x R980	24	0.0	56.2	25.0	4.8
R080H8	F82-546H3 x R980	24	0.0	15.5	62.5	4.5
R080H3	F82-562HO x R980	25	0.0	32.0	40.0	6.3
R080H29	8790A- 6aa x R980	26	0.0	23.0	61.5	5.0
R080H30	-15aa x R980	24	0.0	21.2	62.5	3.5
R080H31	8790A-23aa x R980	22	0.0	8.1	81.8	5.5
R080H32	-47aa x R980	22	0.0	13.0	54.5	5.0
R080H33	-54aa x R980	26	0.0	20.0	69.2	4.5
R080H34	-55aa x R980	28	0.0	2.2	92.9	5.8
R080H35	-61aa x R980	25	0.0	24.4	32.0	5.5
R080H36	-71aa x R980	20	0.0	13.2	65.0	4.5
R080H90	8790Laa x R980	25	0.0	35.0	56.0	5.0
0790H12	9912aa x 8790-S_1(C)	27	0.0	13.8	55.6	5.5

[1]Corresponding lines and testcross hybrids with R980. 0790-#'s (8790-#'s) = increases of S_1 lines from popn-790(C4). E840 = C40 = highly susceptible Erwinia check.

TEST 2191. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION OF HYBRIDS, SALINAS, CA., 1991

64 entries x 2 replications
1-row plots, 18 ft. long

Planted: April 16, 1991
E.c.b. Inoculated: July 11, 1991
Scored: October 2, 1991

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	Erwinia Reaction[2] % Resistant	P.M. Avg.[3]
E840	Inc. E440, E640 (C40)	29	0.0	89.1	7.1	7.9
E840H72	83-718HO x E440 (C40)	24	0.0	67.2	15.1	7.1
E840H8	F82-546H3 x E440 (C40)	26	0.0	27.1	55.9	7.4
US H11	L786442	26	0.0	5.1	88.6	7.4
WS-PM 9	PMR Hilleshog	27	0.0	12.1	66.7	4.9
Vyxen	VYR monogerm hybrid	24	0.0	15.4	71.1	5.6
HM 2009	Hilleshog VYR hybrid	26	0.0	7.5	80.8	7.0
B6625	Beta 6625 (0011-1)	27	0.0	5.6	84.6	6.4
Rhizosen	L493302	25	0.0	17.6	69.4	6.4
HH41	L412305	27	2.0	19.5	62.4	6.3
HH54	L543003	26	0.0	21.7	70.4	6.1
4757	Betaseed	27	0.0	5.6	79.6	5.0
SSNB3	Spreckels (1/22/89)	28	0.0	3.0	89.0	6.8
Y039H20	87-309H3 x Y939 (C39)	24	0.0	14.9	73.5	5.8
R039C5H20	87-309H3 x R939C5	25	0.0	19.8	66.1	6.1
Y048H20	87-309H3 x Y948 (C93)	28	0.0	7.4	82.0	7.1
Y047H20	87-309H3 x Y947 (C47)	27	0.0	5.9	86.9	6.8
R047C5H20	87-309H3 x R947C5	25	0.0	5.6	84.0	7.3
R020H20	87-309H3 x R920 (C94)	27	0.0	22.0	70.4	6.9
R070H20	87-309H3 x R971-R980	25	0.0	6.7	77.3	6.8
Y054H20	87-309H3 x BYR Y854	26	0.0	6.2	79.0	5.5
R080H20	87-309H3 x R980	27	0.0	12.3	75.8	6.9
Y054- 2H20	87-309H3 x Y854- 2	26	0.0	15.5	71.9	6.4
Y054-12H20	87-309H3 x Y854-12	29	0.0	8.0	73.7	5.8
Y054-23H20	87-309H3 x Y854-23	26	0.0	6.1	84.6	6.3
-38H20	87-309H3 x Y854-38	25	0.0	2.8	92.0	5.3
-63H20	87-309H3 x Y854-63	25	0.0	11.2	72.0	6.5
-85H20	87-309H3 x Y854-85	26	0.0	8.9	73.0	5.8
Z010H20	87-309H3 x Polish 1-7	26	0.0	12.6	67.5	7.1
Z012H20	87-309H3 x Polish-2	26	0.0	22.5	55.0	7.0
Z014H20	87-309H3 x Polish-4	23	0.0	22.9	58.3	7.6
E840	Inc. E440, E640	24	0.0	90.5	6.5	7.6
0906- 4H20	87-309H3 x 8906A- 4	27	0.0	9.5	79.3	6.8
0906- 7H20	87-309H3 x 8906A- 7	25	0.0	14.2	75.7	6.5

TEST 2191. ERWINIA ROOT ROT AND POWDERY MILDEW EVALUATION AND OBSERVATION OF HYBRIDS, SALINAS, CA., 1991

(continued)

Variety	Description	Harv. Count/ Plot	Downey Mildew %[1]	Erwinia Reaction[2] DI	Erwinia Reaction[2] % Resistant	P.M. Avg.[3]
0909- 7H20	87-309H3 x 8909A- 7	28	0.0	3.7	92.7	6.1
0909-34H20	87-309H3 x 8909A-34	24	0.0	2.7	82.9	5.3
0909-37H20	87-309H3 x 8909A-37	27	0.0	8.1	79.3	4.5
0909-48H20	87-309H3 x 8909A-48	24	0.0	16.9	74.1	5.6
0913H20	87-309H3 x 9911H49	26	0.0	14.0	73.3	6.3
0913H8	F82-546H3 x 9911H49	20	0.0	6.4	82.7	5.3
R080H8	F82-546H3 x R980	24	0.0	9.5	75.9	5.9
R080H18	88-790-68H26 x R980	22	0.0	16.1	73.3	5.3
R080H23	87-309H37 x R980	23	0.0	20.7	62.1	5.8
R080H26	87-309CMS x R980	23	0.0	8.9	76.3	6.8
R080H37	9807HO (C306) x R980	25	0.0	49.3	32.6	6.4
R080H38	89-312CMS x R980	21	0.0	34.3	44.4	5.0
R080H39	89-762-17CMS x R980	25	0.0	32.0	40.7	5.9
R080H40	89-313CMS x R980	23	0.0	25.9	52.8	4.8
R080H42	C742-24HO x R980	25	0.0	16.1	62.2	4.5
R080H54	C767-46HO x R980	24	1.9	8.0	84.4	4.4
R080H66	C766-23HO x R980	22	0.0	14.1	68.1	6.3
R080H70	C766-62HO x R980	22	0.0	10.1	82.2	6.0
R080H72	83-718HO x R980	25	0.0	23.9	61.3	6.6
R080H89	88-790-68CMS x R980	23	0.0	24.8	54.6	5.6
R080H121	9859mmaa x R980	22	0.0	19.6	66.1	6.3
R080H122	9866mmaa x R980	25	0.0	11.1	77.9	5.1
R080H123	9867mmaa x R980	24	0.0	11.2	83.3	5.8
R080H124	9876mmaa x R980	21	0.0	16.7	61.9	5.6
R080H125	9887mmaa x R980	23	0.0	18.3	61.9	5.4
R080H131	9858aa x R980	24	5.0	18.4	60.8	6.0
R080H132	9865aa x R980	25	0.0	7.8	82.0	6.5
R080H133	9864aa x R980	23	0.0	16.7	72.5	5.8
US H11	L786442	25	0.0	1.7	92.0	6.9
E840	Inc. E440, E640	23	0.0	87.0	10.4	7.9
Mean			0.1	18.4	68.3	6.2
LSD (.05)			2.0	15.1	21.2	1.4
C.V. (%)			726.5	41.2	15.5	11.7
F value			1.0NS	12.8**	6.8**	2.8**

[1,2,3] See Test 2091.

TEST 1791. CODED POWDERY MILDEW TEST, 1991

Planted: February 12, 199

160 varieties x 5 replications
1-row plots, 14 ft. long, 20 rows wide

Variety No.	Variety Name	Company	Stand Count	Powdery Mildew Rating 7/31	8/07	8/14	Mean
PM- 1	HH-77	Holly	21	4.4	6.0	7.8	6.07
PM- 2	HM 3015	HM	20	4.4	5.8	7.2	5.80
PM- 3	SS-334R	Spreck	20	6.2	7.6	8.6	7.47
PM- 4	89-1459-041	Holly	21	4.4	5.2	7.0	5.53
PM- 5	89N 158-015	Holly	21	4.0	5.4	7.2	5.53
PM- 6	85C 62-016	Holly	22	4.2	5.6	7.2	5.67
PM- 7	4625	Beta	21	3.8	5.6	6.8	5.40
PM- 8	H89298	Spreck	21	5.4	6.4	8.2	6.67
PM- 9	SS-377	Spreck	22	5.0	6.0	8.0	6.33
PM- 10	OBG6365	Beta	21	4.4	5.6	6.6	5.53
PM- 11	SS-NB3	Spreck	21	4.2	5.8	7.6	5.87
PM- 12	H87398	Spreck	21	4.4	5.6	7.6	5.87
PM- 13	H88236	Spreck	21	4.0	5.4	7.4	5.60
PM- 14	6BG6207	Beta	21	3.0	4.8	6.2	4.67
PM- 15	SS-462R	Spreck	20	6.2	7.8	8.8	7.60
PM- 16	H89684	Spreck	21	4.8	6.2	7.8	6.27
PM- 17	H87245	Spreck	20	4.0	5.6	6.8	5.47
PM- 18	SS-270	Spreck	17	4.8	6.2	7.2	6.07
PM- 19	H90636	Spreck	21	5.0	6.8	8.4	6.73
PM- 20	89C 58-07	Holly	21	5.8	7.2	8.4	7.13
PM- 21	84C 39-024	Holly	20	5.0	6.0	7.6	6.20
PM- 22	H87316	Spreck	20	5.8	7.0	8.0	6.93
PM- 23	SS-231	Spreck	20	3.4	5.0	6.8	5.07
PM- 24	HM 3005	HM	20	3.8	5.4	7.0	5.40
PM- 25	87C 40-012	Holly	21	5.6	6.8	7.8	6.73
PM- 26	SS-502	Spreck	21	4.8	6.4	7.6	6.27
PM- 27	HH-56	Holly	20	4.8	6.0	7.2	6.00
PM- 28	SS-Y1	Spreck	20	4.8	5.6	7.6	6.00
PM- 29	H90280	Spreck	20	4.6	6.4	8.0	6.33
PM- 30	7BG6103	Beta	22	4.0	5.0	6.8	5.27
PM- 31	H87354	Spreck	20	4.0	5.4	7.2	5.53
PM- 32	9BG6379	Beta	20	3.0	4.0	5.0	4.00

TEST 1791. CODED POWDERY MILDEW TEST, 1991
(continued)

Variety No.	Variety Name	Company	Stand Count	Powdery Mildew Rating 7/31	8/07	8/14	Mean
PM- 33	H90287	Spreck	21	6.2	7.2	8.0	7.13
PM- 34	9BG6346	Beta	21	4.8	6.6	7.4	6.27
PM- 35	89-1459-056	Holly	20	4.2	6.2	7.2	5.87
PM- 36	4480	Beta	22	3.4	5.6	7.0	5.33
PM- 37	6BG6209	Beta	20	3.0	4.8	6.2	4.67
PM- 38	SS-Z2	Spreck	21	5.2	7.0	8.4	6.87
PM- 39	8BC6391	Beta	21	3.8	5.6	7.2	5.53
PM- 40	86C 148-04	Holly	20	5.2	7.6	8.6	7.13
PM- 41	89-1459-082	Holly	21	6.4	7.4	8.6	7.47
PM- 42	H89238	Spreck	21	4.0	5.0	6.0	5.00
PM- 43	HM 6036	HM	20	3.0	5.2	7.0	5.07
PM- 44	86-84C80-05	Holly	20	4.4	5.8	7.0	5.73
PM- 45	89N 158-029	Holly	21	4.6	6.6	7.8	6.33
PM- 46	86-1459-026	Holly	21	5.6	6.2	8.0	6.60
PM- 47	HM 3020	HM	21	4.0	5.2	6.2	5.13
PM- 48	HH-69	Holly	22	6.0	6.8	8.6	7.13
PM- 49	H88199	Spreck	21	3.0	5.4	7.6	5.33
PM- 50	86C 15-014	Holly	20	3.8	5.6	7.6	5.67
PM- 51	H87240	Spreck	21	3.6	5.0	7.4	5.33
PM- 52	HM 6027	HM	20	4.0	5.6	7.2	5.60
PM- 53	HH-38	Holly	21	4.0	5.6	7.2	5.60
PM- 54	86-84C65-05	Holly	21	5.0	6.8	8.0	6.60
PM- 55	4587	Beta	21	5.0	6.2	8.0	6.40
PM- 56	HH-54	Holly	19	4.4	5.4	7.4	5.73
PM- 57	8BG6169	Beta	21	5.0	6.6	7.6	6.40
PM- 58	HM 3019	HM	21	4.2	5.8	7.2	5.73
PM- 59	H90543	Spreck	21	4.4	6.0	7.6	6.00
PM- 60	OBG6217	Beta	21	3.8	5.2	6.2	5.07
PM- 61	90C 63-04	Holly	20	4.4	5.8	7.4	5.87
PM- 62	90C 148-06	Holly	20	4.2	5.8	7.2	5.73
PM- 63	9BG6374	Beta	20	2.4	4.2	5.8	4.13
PM- 64	9BG6271	Beta	21	4.2	6.0	7.6	5.93
PM- 65	HM 3018	HM	21	4.0	5.4	7.0	5.47
PM- 66	H88289	Spreck	21	4.4	5.4	7.2	5.67
PM- 67	86-84C25-013	Holly	20	4.0	6.0	7.4	5.80
PM- 68	HH-84	Holly	21	4.6	6.4	8.2	6.40

TEST 1791. CODED POWDERY MILDEW TEST, 1991
(continued)

Variety No.	Variety Name	Company	Stand Count	Powdery Mildew Rating 7/31	8/07	8/14	Mean
PM- 69	88-1459-049	Holly	22	5.8	7.0	8.8	7.20
PM- 70	HM 5330	HM	21	4.2	5.2	5.8	5.07
PM- 71	9BG6371	Beta	21	4.0	6.8	8.0	6.60
PM- 72	9BG6380	Beta	21	3.8	5.0	6.6	5.13
PM- 73	HH-80	Holly	22	5.8	7.4	8.6	7.27
PM- 74	HH-81	Holly	21	5.8	7.6	8.6	7.33
PM- 75	88C 155-016	Holly	22	5.4	6.8	8.4	6.87
PM- 76	HM 3013	HM	21	5.6	6.8	8.2	6.87
PM- 77	US H11	Stand.	22	5.4	7.0	8.8	7.07
PM- 78	8BC6384	Beta	21	3.2	5.0	6.8	5.00
PM- 79	87-1459-080	Holly	21	4.0	5.0	7.6	5.53
PM- 80	90-1459-0108	Holly	21	4.2	5.0	7.2	5.47
PM- 81	89N 158-02	Holly	21	4.6	6.2	8.0	6.27
PM- 82	4757	Beta	20	2.8	4.2	5.8	4.27
PM- 83	H88589	Spreck	21	4.8	6.6	7.8	6.40
PM- 84	7BG6088	Beta	20	2.4	4.4	5.2	4.00
PM- 85	0BG6113	Beta	21	4.4	6.0	7.2	5.87
PM- 86	SS-NB2	Spreck	21	5.2	7.0	8.6	6.93
PM- 87	OBG6431	Beta	21	3.0	4.2	6.0	4.40
PM- 88	H87356	Spreck	21	4.6	6.8	8.2	6.53
PM- 89	HH-85	Holly	19	4.6	5.4	7.4	5.80
PM- 90	89-1459-015	Holly	21	3.6	4.4	6.0	4.67
PM- 91	HH-41	Holly	20	5.0	7.2	8.2	6.80
PM- 92	9BG6381	Beta	21	4.2	5.6	6.4	5.40
PM- 93	HH-37	Holly	20	5.6	6.8	8.4	6.93
PM- 94	H88249	Spreck	21	4.8	6.2	7.8	6.27
PM- 95	H89760	Spreck	20	4.6	5.8	7.6	6.00
PM- 96	87C 40-011	Holly	20	5.2	6.2	7.6	6.33
PM- 97	8BG6329	Beta	21	4.6	6.6	7.6	6.27
PM- 98	HM 3012	HM	21	5.2	6.6	8.0	6.60
PM- 99	HM 3014	HM	20	1.4	4.0	4.6	3.33
PM-100	HM 3016	HM	21	3.8	5.8	7.6	5.73
PM-101	9BG6276	Beta	19	4.0	6.2	7.6	5.93
PM-102	HM 3017	HM	21	5.4	7.4	8.6	7.13
PM-103	H88242	Spreck	20	4.0	5.4	7.4	5.60
PM-104	Hill 2	HM	21	3.0	4.0	5.2	4.07

TEST 1791. CODED POWDERY MILDEW TEST, 1991
(continued)

Variety No.	Variety Name	Company	Stand Count	Powdery Mildew Rating 7/31	8/07	8/14	Mean
PM-105	OBG6336	Beta	19	2.4	3.6	5.2	3.73
PM-106	USC-1	Holly	20	4.0	5.8	8.2	6.00
PM-107	SS-Z1	Spreck	19	5.4	6.6	8.2	6.73
PM-108	H88500	Spreck	22	5.2	6.8	8.2	6.73
PM-109	87C 40-08	Holly	01	5.8	7.2	8.2	7.07
PM-110	HH-46	Holly	21	4.4	5.6	7.0	5.67
PM-111	89-1459-092	Holly	21	4.4	6.2	7.4	6.00
PM-112	89N 158-017	Holly	21	4.4	6.0	7.6	6.00
PM-113	HH-66	Holly	21	5.2	6.4	7.6	6.40
PM-114	H88335	Spreck	21	3.2	5.2	6.6	5.00
PM-115	87C 40-013	Holly	20	3.6	5.8	7.8	5.73
PM-116	HH-79	Holly	21	5.8	7.4	8.6	7.27
PM-117	89-84C65-07	Holly	20	4.4	5.8	7.2	5.80
PM-118	9BG6372	Beta	21	3.6	4.8	6.0	4.80
PM-119	SS-334	Spreck	21	4.2	5.6	8.0	5.93
PM-120	H88287	Spreck	21	4.8	6.2	8.0	6.33
PM-121	90-1459-167	Holly	21	4.2	5.8	7.6	5.87
PM-122	7BG6092	Beta	21	2.6	4.2	5.4	4.07
PM-123	US H11	Stand.	21	5.4	7.4	8.6	7.13
PM-124	H90547	Spreck	21	5.8	7.4	8.4	7.20
PM-125	4581	Beta	21	4.0	4.6	6.2	4.93
PM-126	HH-70	Holly	20	6.4	7.8	8.2	7.47
PM-127	OBG6177	Beta	21	4.0	5.6	6.6	5.40
PM-128	H87545	Spreck	21	5.4	7.2	7.8	6.80
PM-129	SS-LS2	Spreck	21	4.2	5.8	7.4	5.80
PM-130	HM 3021	HM	21	3.8	5.0	6.2	5.00
PM-131	HH-45	Holly	21	4.6	6.0	7.6	6.07
PM-132	H86519	Spreck	21	5.6	7.2	8.6	7.13
PM-133	9BG6257	Beta	20	4.6	5.8	7.6	6.00
PM-134	86-1459-038	Holly	20	5.2	6.0	8.0	6.40
PM-135	US H11	Stand.	20	6.0	7.4	8.8	7.40
PM-136	89C 58-03	Holly	20	6.4	7.6	9.0	7.67
PM-137	9BG6272	Beta	21	6.2	7.4	8.2	7.27
PM-138	9BG6270	Beta	20	5.0	6.6	8.0	6.53
PM-139	H87497	Spreck	22	5.0	6.4	8.0	6.47
PM-140	H86558	Spreck	21	3.6	5.0	6.0	4.87

TEST 1791. CODED POWDERY MILDEW TEST, 1991
(continued)

Variety No.	Variety Name	Company	Stand Count	Powdery Mildew Rating 7/31	8/07	8/14	Mean
PM-141	OBG6351	Beta	20	3.0	4.0	5.2	4.07
PM-142	HH-55	Holly	20	3.4	4.6	6.0	4.67
PM-143	OBG6488	Beta	20	5.0	6.0	7.2	6.07
PM-144	9BG6259	Beta	20	4.6	6.2	7.6	6.13
PM-145	8BG6332	Beta	21	4.2	6.2	7.4	5.93
PM-146	US H11	Stand.	21	6.0	7.8	8.8	7.53
PM-147	Rhizosen	Holly	21	5.4	7.2	8.4	7.00
PM-148	OBG6486	Beta	20	4.6	5.4	7.6	5.87
PM-149	SS-181	Spreck	22	4.0	6.2	7.2	5.80
PM-150	H89262	Spreck	21	3.2	5.4	6.6	5.07
PM-151	H86246	Spreck	21	3.0	5.2	6.4	4.87
PM-152	90C 62-011	Holly	21	5.2	6.8	8.2	6.73
Entries added by USDA							
US H11		USDA	22	6.4	7.8	8.8	7.67
US H11		USDA	20	6.0	7.4	8.2	7.20
WS-PM-9		HM	21	3.0	4.8	6.6	4.80
WS-PM-9		HM	20	3.2	5.2	6.8	5.07
WS-PM-9		HM	21	2.6	4.4	6.8	4.60
WS-PM-9		HM	20	3.2	4.8	6.4	4.80
Y039		USDA	18	0.2	3.0	3.0	2.07
Y039		USDA	18	1.4	3.2	4.0	2.87
Mean			20.5	4.4	5.9	7.4	5.9
LSD (.05)			1.6	1.2	1.0	1.1	0.85
C.V. (%)			6.4	11.7	13.8	11.7	11.6
F value			9.0**	6.8**	7.4**	6.8**	10.3**

Footnote:
Powdery mildew scored on a scale of 0 to 9, where 9 = 90-100% of visible leaf area infected. In 1991, mildew was late to start but then developed quickly and to a high incidence. To retain differences between entries, only three weekly ratings were used to calculate the mean powdery mildew (area under disease progress curve).

Entry #109 had two missing plots and very poor stands and data may not be accurate.

TEST RZM 991. 1991 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1991

64 entries[9] x 3 reps, RCB
1-row plots, 10 ft., long

Planted: June 5, 1991
Natural infection to BWYV
Harvested: December 5, 1991

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/03	#74 Rhizomania[7] DI	#74 Rhizomania[7] %H	#81 Beet Cyst Nematode[8]
Ames 4188	Unknown	31	8	2	2	4	1	3.7	7.0	6.2	2
Ames 4191	Unknown	47	8	1	2	4	1	5.0	8.3	37.9	2
Ames 4192	US	35	8	1	2	4	1	?	9.0	37.9	2
Ames 4206	Israel	45	8	2	2	4	1	4.7	7.0	37.9	2
Ames 4224	France	26	6	2	2	4	3	4.3	3.9	56.7	3
Ames 4227	Greece	41	8	2	2	4	1	5.0	8.3	37.9	3
Ames 4230	Greece	40	8	2	2	4	1	4.7	6.6	65.1	3
Ames 4240	France	30	6	1	2	4	2	3.0	3.8	61.5	3
Ames 4241	France	43	6	1	2	4	2	3.0	4.0	51.7	2
Ames 4242	Unknown	36	6	1	2	4	2	2.3	3.8	60.2	3
Ames 4264	Turkey	30	8	3	2	4	3	7.0	9.0	37.9	2
Ames 4266	Greece	50	8	1	2	4	1	4.5	6.0	37.9	2
Ames 4267	Unknown	26	8	2	2	4	3	4.7	7.0	0.8	2
Ames 4268	Unknown	23	7	3	2	4	3	4.0	5.7	13.3	2
Ames 4269	Unknown	26	8	1	2	4	1	5.0	9.0	37.9	2
Ames 4271	Unknown	21	8	1	2	4	1	4.3	7.0	0.8	2
Ames 4272	Unknown	29	8	2	2	4	3	6.3	6.3	0.0	2
Ames 4274	Spain	40	8	1	2	4	1	4.3	7.0	37.9	2
Ames 4275	Spain	34	8	1	2	4	1	5.0	7.7	37.9	2
Ames 4277	Spain	33	8	1	2	4	1	4.3	7.0	37.9	2
Ames 4330	Uncertain	50	5	1	1	1	2	5.7	5.8	4.0	2
Ames 4331	Uncertain	51	5	1	2	1	2	3.0	5.4	12.1	2
Ames 4332	Uncertain	44	5	1	1	1	2	3.3	6.8	0.0	2

TEST RZM 991. 1991 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1991

(continued)

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/03	#74 Rhizomania[7] DI	#74 Rhizomania[7] %H	#81 Beet Cyst Nematode
PI 355960	USSR	40	5	1	1	1	2	5.6	6.9	2.2	2
PI 518298	UK	34	7	1	2	4	2	4.3	4.9	17.8	2
PI 518299	UK	35	6	2	2	4	2	4.3	4.9	18.0	2
PI 518300	UK	43	6	1	2	4	2	2.0	3.8	60.6	2
PI 518301	UK	47	6	1	2	4	2	3.7	3.8	60.2	3
PI 518302	UK	37	6	2	2	4	3	3.7	4.4	31.5	2
PI 518303	UK	46	6	1	2	4	2	3.7	4.0	50.6	3
PI 518306	UK	41	6	1	2	4	2	3.3	3.4	81.3	3
PI 518307	UK	48	6	1	2	4	2	5.0	4.2	41.9	2
PI 518313	UK	49	6	1	2	4	2	5.3	4.0	49.9	3
PI 518316	UK	36	6	3	2	4	2	5.0	4.4	31.1	2
PI 518317	UK	43	6	1	2	4	2	5.3	4.2	47.2	2
PI 518322	UK	44	6	3	2	4	2	3.6	3.4	79.8	3
PI 518327	UK	46	6	2	2	4	3	2.7	4.2	42.1	3
PI 518328	UK	33	6	3	2	4	2	4.6	5.4	18.2	2
PI 518329	UK	38	6	1	2	4	2	2.3	3.3	82.8	3
PI 518330	UK	42	6	1	2	4	2	3.3	4.5	36.4	3
PI 518332	UK	32	6	1	1	1	2	5.3	5.9	9.4	2
PI 518333	UK	35	6	1	2	4	2	3.7	4.9	22.9	2
PI 518338	UK	35	6	1	2	4	3	4.3	5.3	11.8	2
PI 518341	UK	39	6	1	2	4	2	3.3	4.4	37.0	2
PI 518342	UK	34	6	1	2	4	2	2.6	4.0	47.7	3
PI 518343	UK	36	6	1	2	4	2	4.3	4.2	43.9	2
PI 518345	UK	33	6	1	2	4	2	3.3	4.6	32.1	2

TEST RZM 991. 1991 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1991

(continued)

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/03	#74 Rhizomania[7] DI	#74 Rhizomania[7] %H	#81 Beet Cyst Nematode
PI 518356	UK	33	6	1	2	4	2	2.7	4.2	39.4	2
PI 518358	UK	40	6	1	2	4	2	2.3	3.7	63.3	3
PI 518364	UK	43	6	1	2	4	2	3.3	4.5	36.3	3
PI 518369	UK	41	6	1	2	1	2	3.3	4.3	44.3	2
PI 518370	UK	37	6	1	2	4	2	4.0	4.1	49.2	2
PI 518372	UK	35	6	3	2	4	3	4.3	3.9	57.3	2
PI 518381	Ireland	48	6	1	2	4	3	4.0	4.5	34.4	2
PI 518385	Ireland	28	6	2	2	4	3	3.7	5.0	17.8	2
PI 518390	Ireland	38	6	1	2	4	3	3.3	4.3	38.0	2
PI 518400	Ireland	26	6	2	2	4	2	2.7	3.4	84.8	2
PI 518415	Ireland	22	6	3	2	4	2	3.7	4.2	50.0	3
PI 518416	Ireland	38	6	1	2	4	2	2.3	4.2	41.5	3
PI 518398	Ireland	28	6	3	2	4	3	6.0	5.4	6.1	2
Checks											
US H11	USDA	45	5	1	1	1	2	4.7	6.9	0.0	2
R039C5	USDA	39	5	1	2	1	2	3.0	3.2	74.9	2
0911	USDA	51	5	1	2	1	2	2.3	3.8	70.0	2
SP7622-0	USDA	41	1	1	1	1	2	6.7	6.6	0.0	2

TEST RZM 991. 1991 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1991

(continued)

[1] #1 End use based upon field plot appearance where: 1=chard; 2=DDR-like; 3=DDR, chard, spinach; 4=fodder; 5=sugar; 6=wild beet type; 7=mixed, 8=annual.

[2] #5 Population Uniformity: 1=all plants alike; 2=uneven different types; 3=mixed, green, red, yellow, high, low, large leaves, small leaves, etc.

[3] #12 Mature Leaf Blade Pigmentation: 1=light green (chard), 2=green, 3=red & green, 4=red, 5=mutant.

[4] #19 Petiole Color: 1=green, 2=pink, 3=red, 4=candy stripe, 9=yellow, 6=mixed.

[5] #37 Bolting Tendency without cold induction: 1=B-(annual)=100%, 2=bb(biennial)-0%, 3=B:bb(mixed) 1-99%.

[6] #61 Beet Western Yellows (BWYV): 0=immune; 1=very resistant; 3=resistant; 5=intermediate; 7=susceptible; 9=highly susceptible based upon yellowing of leaves. Mean disease ratings (DI) from Oct. 3, 1991.

[7] #74 Rhizomania: DI-disease index based upon 0=no visual symptoms; 1=very minor root symptoms; 3=normal tap root, slight bearding; 5=wine-glass shaped, bearded, moderate damage; 7=severly damaged, loss of tap root; 9=dead due to rhizomania %Healthy=classes (0+1+2+3)/total.

[8] #81 Beet Cyst nematode: Natural infection in field and visual rating at harvest where: 1=Nematode res.; 2=Nematode Susc.; 3=Seg.

64 entries = 60 PI lines from Ames plus checks. Checks are: US H11=highly susc. to rhizomnania, mod. susceptible to BWYV; C39 (R039C5) = moderately resistant to BWYV and rhizomania; 0911 = mod. resistant to BWYV and rhizomania; SP7622-0 = susceptible to BWYV and rhizomania.

Conclusion: Roots within some lines of B.maritima showed resistance to rhizomania. Individual plants were selected and will be crossed to sugarbeet to determine the nature and inheritance of this resistance. Many of the B.maritima lines showed very mild symptoms to BWYV. The dark green, thick leaves of B.maritima have a tendency to mask virus yellows sypmtoms. Crosses to sugarbeet will be made to determine if this apparent resistance is heritable. Plants and plots were found free of nematode infestation but this is thought to be field variability rather than genetic resistance. No line or PI was found that was uniformly free of cyst nematode.

SUGARBEET RESEARCH

1991 Report

Section B

Plant Molecular Biology Laboratory
Agricultural Research Service
United States Department of Agriculture
Beltsville, Maryland

Dr. Lowell D. Owens, Plant Physiologist
Dr. Russell O. Nordeen, Molecular Biologist

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Project 800)

CONTENTS

Abstracts of Papers Published or Approved for Publication

Owens, L.D. and D. R. Eberts. 1992. Sugarbeet leaf disc culture: an improved procedure for inducing morphogenesis. *Plant Cell Tiss. Org. Cult.* (In press).

In preparation for gene transfer experiments we investigated factors that might affect the production of shoots and somatic embryos from the wound callus of cultured sugarbeet leaf discs. A complex interaction was found between the leaf disc plating density, the disc culture medium, the source-shoot culture medium and the frequency of disc transfer to fresh medium. The most productive protocol utilized: source shoots maintained on MS medium containing 0.25 mg l^{-1} BA; multiple leaf discs (ten 4-mm discs/plate) plated onto an enriched modification of MS medium (RV) containing 1.0 mg l^{-1} BA and solidified with 0.3 % Gelrite, (not permitted to dry during hardening); and transfer of the discs to fresh medium every two weeks during the first month. This standard protocol produced more callus per plate and higher rates of morphogenesis per unit dry weight of callus than did the one-step method of Saunders and Doley. Water availability considerations were found to be critical to obtaining high morphogenic rates. Root induction frequency and quality was superior on shoots transplanted to MS medium containing 1 mg^{-l} NAA as the sole growth regulator compared to IAA at the same concentration.

Nordeen, R. O. and L. D. Owens. 1992. Introduction and transcription of an antibacterial cecropin gene in tobacco plants. *Plant Physiol. Suppl.* (In press) (Abstract)

We are investigating the feasibility of introducing a modified cecropin gene into plants for protection against bacterial pathogens. Cecropins are a family of small basic polypeptides (~4 kD) that possess potent antibacterial activity and are important in the immune response of insects. A DNA sequence encoding a modified form of the mature cecropin polypeptide was fused to a barley α-amylase secretory sequence DNA by PCR (polymerase chain reaction) and introduced into tobacco (*Nicotiana tabacum*) by transformation with *Agrobacterium tumefaciens*. The progeny of transformed plants that were resistant to kanamycin were analyzed for β-glucuronidase (GUS) and cecropin gene expression. Northern hybridization analysis indicated that about 75% of the R_1 plants produced a transcript of the expected size that hybridized specifically with a cecropin gene probe. Most of these plants also tested positive for GUS. Production and stability of cecropin polypeptide is currently being analyzed.

Owens, L.D. 1992. Measurement of water availability in gel-solidified culture media. (Letter to the Editor) *Agricell Rep.* 18:11. (Industry publication)

Plant nursery operators and scientists alike have a problem in choosing the right gelling agent for their particular tissue application. This problem is made worse by the recent explosion of new gel products on the market. None of these gelling agents are defined in terms of the physical property most important to cultured tissues, namely water availability as determined mainly by the matric potential of the gel. Only recently have methods been devised for measuring the matric potential of gels. Of the three published methods two (Beruto and Debergh, Acta Hort. 289:331,1991; Obeidy and Smith, Plant Cell Rep. 9:463, 1990) employ rate measurements of water loss from gels; but since the rates may not be linear, the measurements may not accurately reflect the equilbrium value. Other methodological deficiencies of these two methods either render the measurements sensitive to slight temperature and relative humidity fluctuations or introduce errors caused by gravitational potential and gel shrinkage. In contrast the method of Owens and Woziak (Plant Cell Tiss. Org. Cult. 26:127, 1991) is simple and quick; minimizes errors due to gravitational potential and gel shrinkage; utilizes equilibrium measurements; and has a proven accuracy in predicting the physiological performance of various gels with cultured tissue.

Hatfield, D., C. I. Soon, S. Mischke and L. D. Owens. 1992. Selenocysteyl-tRNAs recognize UGA in *beta vulgaris*, a higher plant, and in *Gliocadium virens*, a filamentous fungus. *Biochem. Biophys. Res. Comm.* (In press).

Selenocysteyl-tRNAs that decode UGA were previously identified in representatives of three of the five kingdoms, namely the monera, animal and protist kingdoms. In the present study we show that these tRNAs also occur in representatives of the two remaining kingdoms, plants and fungi; i.e., selenocysteyl-tRNAs which code for UGA occur in *Beta vulgaris*, a higher plant and in *Gliocladium virens*, a filamentous fungus. The fact that selenocysteyl-tRNAs are present in all five life kingdoms strongly suggests that UGA, in addition to dictating the cessation of protein synthesis, also codes for selenocysteine in the universal genetic code.

Papers Published Since Abstracted in Previous Report

Nordeen, R.O., S. L. Sinden, J. M. Jaynes and L. D. Owens. 1992. Activity of cecropin SB37 against protoplasts from several plant species and their bacterial pathogens. *Plant Sci.* 82: 101-107.

Owens, L. D. and C. A. Wozniak. 1991. Measurement and effects of gel matric potential and expressibility on production of morphogenic callus by cultured sugarbeet leaf discs. *Plant Cell Tiss. Org. Cult.* 26:127-133.

ENGINEERED RESISTANCE TO BACTERIAL PATHOGENS
BSDF Project 800

R. O. Nordeen and L. D. Owens

Introduction and transcription of cecropin gene in tobacco plants - Cecropins are a family of small polypeptides (~40 amino acids in length) that possess potent antibacterial activity and are important to the immune response of insects. A synthetic version of cecropin B was constructed. It consists of the coding region of cecropin fused (by polymerase chain reaction techniques) to the secretory sequence from barley α-amylase and placed under control of a tandem 35S promoter from cauliflower mosiac virus. This gene construct, called MB39, was introduced into the model test plant tobacco by *Agrobacterium tumefaciens*-mediated gene transfer. Plants were selected on kanamycin and scored for β-glucuronidase (GUS) expression. GUS-positive regenerants (R_0) were selfed and taken to seed. Germination of the seed on kanamycin medium indicated a 3:1 segregation pattern of a monohybrid for kanamycin resistance. Northern hybridization analyses of kanamycin-resistant progeny (R_1) indicated that about three fourths produced an mRNA transcript of the expected size that hybridized with a cecropin gene probe. More than 90 % of the R_1 plants also tested positive for GUS. There was a fair correspondence between the level of GUS expression, as visually determined from a histochemical assay, and the amount of cecropin transcript. This correlation probably reflects the inherent transcriptional activity of the chromosomal site of T-DNA integration.

Stability of cecropin to intercellular extracts from plant leaves - Overnight incubations of cecropin with intercellular extracts from tobacco leaves resulted in considerable degradation. The degradation could be prevented by initially heating the extract to 100 °C indicating the presence of proteases. Preliminary results suggest that cecropin is more stable in intercellular extracts from sugarbeet than from tobacco.

GENE TRANSFER TECHNOLOGY IMPROVEMENT

L. D. Owens

UGA Codon usage in sugarbeet - Sugarbeet suspension cells were used to demonstrate that the codon UGA, in addition to its assignment as a

translation stop signal in the universal genetic code, also serves as the codon for the essential amino acid selenocysteine. $^{75}SeO^{2-}{}_3$ was fed to log phase sugarbeet cells, and the resulting ^{75}Se-containing aminoacyl-tRNAs were isolated from the cells and seperated by chromatography. Sugarbeet extracts were found to contain two large peaks and a smaller one that were radiolabeled. All three peaks specifically recognized and bound the trinucleotide diphosphate of UGA, as determined by the ribosomal binding assay. That the ^{75}Se-containing moiety attached to the UGA-recognizing tRNAs was, in fact, selenocysteine was determined by deacylating the aminoacyl-tRNA from each peak and characterizing the amino acid product by chromatography. Thus, there appear to be at least three isoaccepting tRNAs in sugarbeet that accept selenocysteine and recognize UGA. This codon usage information could be critical for cloning genes from sugarbeet that encode proteins containing selenocysteine and for chemically synthesizing such genes.

Improvement of *Agrobacterium* gene vectors for sugarbeet - Of the several classes of *Agrobacterium tumefaciens*, we had previously shown that a wild type strain (A281) of the succinamopine class was vastly superior in forming tumors on excised sugarbeet petioles as compared to an octopine type strain. This "supervirulence" may be due to more efficient transfer of T-DNA to the recipient plant cell and/or integration into the chromosome. To test this hypothesis a binary vector carrying genes for cecropin, GUS and NPTII (kanamycin resistance) within T-DNA borders was constructed (pGT3941) and mated into the disarmed (non-tumorigenic) version of A281 (called strain EHA101). The binary vector pGT3941 was similarly mated into disarmed strains of the octopine and nopaline classes of *A. tumefaciens*. To insure a uniform chromosomal background the host strain for all three classes of disarmed virulence plasmids was C58 cured (voided) of its resident Ti plasmid.

The ability of each virulence plasmid to transfer the T-DNA carried on the binary plasmid construct pGT3941 was tested by inoculating tobacco leaf discs and plating them on kanamycin-containing medium. The rapidity with which kanamycin-resistant (and GUS-positive) shoots appeared was taken as an indication of virulence. In repeated tests the succinamopine-type virulence plasmid pEHA101 was clearly superior to the nopaline type - producing transgenic shoots 1 to 2 weeks earlier. The comparison with the octopine-type virulence plasmid was variable - pEHA101 displayed superiority in one experiment and equal virulence in the second. An interaction between virulence response and the physiological state of the cultured shoots likely accounted for this variation. We conclude that the supervirulent vector is efficient and ready for use with sugarbeet.

SUGARBEET RESEARCH

1991 REPORT

Section C

Crops Research Laboratory, Agricultural Research Service
U.S. Department of Agriculture, Fort Collins, Colorado

Dr. E. G. Ruppel, Plant Pathologist
Dr. S. S. Martin, Plant Physiologist
Ms. M. E. McClintock, Biological Lab Tech.
Dr. R. J. Hecker, Geneticist (retired)

Cooperation:

Colorado Agricultural Experiment Station

This research was supported in part by funds provided through the
Beet Sugar Development Foundation
(Projects 402, 403, 903, and 904)

Contents

Publications

Abstracts of Papers Presented, Published, or Approved for Publication.

Ruppel, E. G. 1992. <u>Survival of Rhizoctonia solani in fallow field soil and buried sugarbeet roots at three depths</u>. J. Sugar Beet Res. 28:141-153.

Survival of *Rhizoctonia solani* AG-2-2 in infected sugarbeet root tissue and in soil adjacent to the roots at 5-, 10-, and 20-cm depths in fallow field soil was assayed bimonthly in two tests between June 1988-June 1989 and June 1989-June 1990. By August, percent recovery of the fungus from tissue declined 80 and 74% in 1988 and 1989, respectively. Thereafter, recovery was variable but generally continued to decline in both years. In the first test, *R. solani* was not recovered from root tissue buried 5-cm deep after 4 mo, but in the second test, tissue buried at 5 cm yielded the fungus throughout the year. For tissue buried 10 cm deep, the fungus survived without decline for 6 mo in 1988, but only for 4 mo in 1989. In 1988-89, the fungus was not recovered from tissue buried 20-cm deep after 2 and 4 mo, but was recovered at the 6- and 12-mo assays. In 1989-90, *R. solani* was recovered only at the 2- and 4-mo assays from tissue buried 20-cm deep. Population densities of *R. solani* were 1.6-2.0 colony-forming units (CFU) per gram of air-dry soil at the 2-mo assay in 1988 and 1989, respectively. Thereafter, population densities tended to decline over time in both years, reaching 0.5-0.7 CFU g^{-1} after 12 mo. All isolates from buried tissue and a 10% random sample of soil isolates were pathogenic in 3-mo-old sugarbeets in the greenhouse, except for one AG-4 isolate from soil. Decline in pathogen survival apparently was not related to precipitation or air and soil temperatures but may have been associated with the degradation of organic food base.

Martin, S. S. and Lynn L. Hoefert. 1991. <u>Glucosinolate biochemistry and structure of trap crops for the sugar-beet cyst nematode (Heterodera schachtii)</u>. Amer. J. Bot. Suppl. 78(6): 142. (Abstract)

Selected cultivars of *Raphanus sativus* or *Sinapis alba* (Brassicaceae) induce cyst hatching and attract larvae of the sugarbeet cyst nematode, but disrupt normal reproduction. Such plants can be used as "trap" crops to reduce field nematode levels. As part of a study of the mode of action of these nematode-trapping plants, we compared the distribution of specialized glucosinolate-containing cells (GCCs) in seedlings of trap- and nontrap-crop cultivars of *R. sativus* and *S. alba*, and determined quantitative glucosinolate (GSL) profiles in seeds and developing seedlings. Structural studies were made by light and electron microscopy. For biochemical work, tissues were extracted in boiling 75% methanol; intact glucosinolates were analyzed by HPLC [C18-column; gradient elution with mixtures of 0.1 M (aq.) ammonium acetate and acetonitrile] with photodiode array UV detection. In specialized GCCs, GSLs or precursors accumulated via endoplasmic reticulum cisternae that fused with the central vacuole to produce a cell lumen filled with biochemical material. Number and distribution of GCCs differed between trap and non-trap cultivars. All *S. alba* samples contained mainly 4-hydroxybenzyl-GSL (glucosinalbin), with small amounts of three other GSLs. Seed of *R. sativus* contained 4-methylsulfinyl-but-3-enyl-GSL as the predominant GSL; germinating seedlings rapidly synthesized 4-methylthiobut-3-enyl-GSL, with several other GSLs present in lesser amounts.

RHIZOCTONIA ROOT ROT RESEARCH AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGARBEET
(BSDF Project 402)

1991 Field Research on Rhizoctonia Root Rot of Sugarbeet.--E. G. Ruppel and R. J. Hecker (retired).

Our project primarily involved field research conducted on the Colorado State University South Campus in an area reserved for Rhizoctonia root rot research. Our Rhizoctonia research project is a cooperative effort of ARS, the BSDF, and Colorado State University. We are pleased to be able to lead this three-way cooperative research.

The 1991 field experiments were planted on an area that had been in barley for 3 years and was the site of our inoculated Rhizoctonia nursery in 1988. As has been our past experience, no Rhizoctonia root rot occurred from residual fungus before inoculation in 1991. Thus, the dense soil population of *Rhizoctonia* in 1988 essentially had been inactivated during the intervening years of barley culture.

All Rhizoctonia evaluation experiments were planted in one-row plots 56 cm (22 in) apart, and 6.1 m (20 ft) or 4.3 m (14 ft) long. Experiments were planted May 18 and thinned June 24-28. Dry, ground, barley-grain inoculum of *R. solani* (R-9) was banded at 1.97 or 3.11 g/m over each row with a tractor-mounted four-row granule applicator on July 16. One experiment involving our most resistant germplasms received the higher inoculum rate, whereas all other experiments with more susceptible germplasms received the lower rate. Our standard sprinkler irrigation regime was used to moisten and activate the inoculum. Succeeding irrigations were done by furrow.

Roots in all experiments were lifted September 9-13 and individually rated for rot on a disease index (DI) scale of 0 to 7, with 0 = no evidence of rot and 7 = plant dead. Percent healthy roots were those with DIs of 0 and 1, roots with no active infection. Roots with DIs 0 through 3 also were analyzed as a class; these roots were sufficiently sound and large to be recovered in a commercial harvest. The root rot epiphytotic in 1991 Rhizoctonia experiments was more severe than that of 1990, but comparable to most previous nurseries. Across the nursery, DI means were 1.8, 2.3, and 5.6 for our highly resistant, resistant, and highly susceptible checks.

Germplasm Developments for Resistance to Rhizoctonia Root Rot.--R. J. Hecker (retired) and E. G. Ruppel.

One of our objectives in this project is the identification and development of sugarbeet germplasms that are genetically resistant to root-rotting strains of *Rhizoctonia solani*. We feel that this objective has been accomplished from a practical standpoint. The most resistant germplasms developed in this project are not immune but had up to 97% harvestable roots in the 1991 inoculated field test at Ft. Collins. We believe that this level of resistance expressed in the rigorous field test should be sufficient to provide adequate protection in most indigenous *Rhizoctonia*-infested fields. However, all the genes for resistance in these germplasms would need to be present on both homologous chromosomes in

commercial hybrids if the same level of resistance is to be expected. In earlier experiments, we have demonstrated that this quantitative resistance shows only a little genetic dominance. It now becomes the task of sugarbeet breeders to incorporate this resistance into their hybrids to the degree necessary to meet various disease intensity potentials.

We have made some effort toward introgression of resistance genes into germplasms with good combining ability and resistance to other diseases. These are listed in Table 1, along with many other entries in our 1991 field test. Following are brief comments about some of the entries and some germplasms that are in the release process.

Entry 472 (FC714) is a monogerm (mm) O-type with excellent resistance. It is being increased and probably will be released in 1992 or 1993. Entries 473-477 and 541-544 are rhizomania-resistant sublines from ARS Salinas, some of which we have further selected for Rhizoctonia resistance. Entries 478-480 (FC720, FC721, & FC721CMS) are mm O-types and a CMS, with some resistance to both *Rhizoctonia* and curly top virus (CTV). They will be released in 1992. Entries 481 and 482 were the result of an effort to integrate Rhizoctonia resistance and good combining ability (CA). This mm O-type and CMS may be released if the Rhizoctonia resistance is improved in current selections. Entry 483 resulted from an effort to develop a multigerm (MM) pollinator with Rhizoctonia resistance and good CA.

Entries 484 and 485 will be released in 1992. This mm O-type and CMS integrate Rhizoctonia and CTV resistance. Entry 488 is a nematode-resistant line from ARS Salinas. It is among the most Rhizoctonia susceptible lines we have ever tested. Entry 489 is the long-time susceptible check. Entries 490 and 491 are a mm O-type and CMS that will be released in 1992. Entries 492 and 498 are MM resistant pollinators that have been released previously.

Entries 501 and 502 are F_2s of Rhizoctonia-resistant lines crossed with the Salinas nematode-resistant line (B883). They show some partial dominance for resistance, which may be of value in the potential development of Rhizoctonia-nematode-resistant hybrids. Entry 504 is a successful introgression of Rhizoctonia and leaf spot resistance (LSR), and it is mm and O-type but it has very low vigor. Entry 508 (FC725) will be released in 1992. It has good Rhizoctonia and CTV resistance; it is designed to serve as a pollinator or a source for pollinator development.

Entries 509 and 510 are a mm O-type and CMS with Rhizoctonia and leaf spot resistance. They are not yet ready for immediate release. Entry 511 (FC709) is the most resistant germplasm we have developed; it was released in 1987. An advanced FC709 will be offered for redistribution in 1992.

Entries 513, 514, and 515 (FC726, FC727, & FC728) are resistant lines with diversity. FC726 originally was 50% fodder beet germplasm. FC727 and FC728 were 50% from high sucrose or commercial hybrid sources. These three germplasms are MM pollinator types and are being released in 1992.

Entries 516-529 are various hybrids or experimental lines. Entry 530 (FC705-1) is the high resistance check. Entries 531 and 532 (FC715 & FC715CMS) integrate Rhizoctonia and leaf spot resistance, with a little resistance to CTV. They are currently being released. Entries 533 and 534 have been O-type indexed and

currently are being synthesized as O-type and CMS lines. They will be released if sufficiently Rhizoctonia resistant. Entries 535-538 are experimental hybrids with 75% of their genes from Rhizoctonia-resistant sources and 25% from susceptible sources. Their value is in having some resistance on the CMS side of hybrids. Entry 540 (FC710) was released in 1990. It is MM and has good resistance. Entries 539 and 545 are the resistant and susceptible checks, respectively.

Currently in the release process are four other germplasms (FC716, FC717, FC718, & FC719). All are Rhizoctonia-resistant MM pollinator types that are diverse and have potential for good CA and high sucrose.

Table 1. Means for Rhizoctonia root rot assessment of germplasms in various stages of resistance development; 1991 inoculated field test

Entry	Germplasm & description[1]	Disease index[2]	Healthy roots (%)	Harvestable roots (%)	Leaf spot rating	Curly top rating	Sucrose %	Kg root/ 20' plot
472	FC714; OT, mm, Rh	1.9	41	93	5.3	7.0	12.9	17.2
473	R820, 1 cy Rh; RZM resist, MM; RZM sel at Salinas	3.4	10	54	6.0	---	--	--
474	R820, 2 cy Rh; RZM resist, MM	4.0	10	39	---	---	--	--
475	R720, 1 cy Rh; RZM resist, MM; RZM sel at Salinas	3.3	18	55	---	---	--	--
476	R720, 2 cy Rh; RZM resist, MM	2.7	19	70	---	7.7	--	--
477	R920, 1 cy Rh; RZM resist, MM	3.7	7	47	6.0	6.3	--	--
478	FC720; C718/FC708, BC1P1, 3 cy Rh; mm, OT, CTR	4.0	9	45	---	---	--	--
479	FC721;Syn(FC701/LSR-CTR)//C718,4 cy Rh;mm, OT,CTR	5.0	4	23	4.8	---	--	--
480	FC721 CMS; C718CMS//Syn(FC701/LSR-CTR), 4 cy Rh; CMS, mm, CTR	3.5	12	49	---	5.0	--	--
481	FC712/Mono-hy A4, 2 cy Rh; OT, ~mm	5.7	1	13	---	---	--	--
482	Mono-hy A4/FC712, 2 cy Rh; CMS, ~mm	4.5	6	25	---	---	--	--
483	FC712/Mono-hy A4, 3 cy Rh; MM	3.1	23	55	6.0	6.3	--	--
484	FC722; C718/FC708, 4 cy Rh; OT, mm, CTR	3.5	4	56	---	---	--	--
485	FC722 CMS; C718CMS/FC708, 4 cy Rh; CMS, mm, CTR	3.4	7	64	---	---	--	--
488	B883; MM, low vigor, nematode resist Salinas line	6.9	0	2	---	---	--	--
489	Rhizoctonia susceptible check	6.2	0	2	---	---	--	--
490	FC723; EL44/FC708, 4 cy Rh; OT, mm	3.1	13	66	---	---	15.0	13.4
491	FC723 CMS; EL44CMS/FC708, 4 cy Rh; CMS, mm	2.7	13	78	---	6.7	15.2	15.0
492	FC708; OT (reindexed), mm, Rh	1.8	36	97	4.8	7.7	15.7	9.4
493	FC708 CMS; mm, Rh	2.2	23	90	4.3	7.7	15.4	12.2
494	FC707(4x); MM, Rh	2.0	31	91	---	---	--	--
495	FC707-2; MM, Rh	2.0	38	92	6.0	7.7	14.1	19.7
496	FC703-5; MM, Rh	2.1	26	91	---	---	--	--
497	FC712; MM, Rh	2.3	27	83	---	---	--	--
498	FC702-7; MM, Rh	2.4	30	79	5.5	7.0	14.3	15.5
501	(Syn fr FC701/mm OT)aa//mm, OT, LSR-CTR///B883,F_2	3.8	4	55	---	---	10.7	20.0
502	FC709rr/B883, F_2	3.8	8	56	---	---	11.7	20.1
504	FC701/LSR-CTR; OT, mm, high LSR, CTS; low vigor, small tops and roots	2.9	5	80	4.3	---	15.0	8.3
506	FC724; FC702/LSR-CTR, 7 cy Rh; OT, mm	2.6	26	77	4.5	7.3	15.5	7.1
508	FC725; C37/FC707-2, 4 cy Rh; MM, CTR	2.8	31	64	4.8	---	--	--
509	FC607/FC708, 4 cy Rh; OT, mm, LSR	3.9	6	43	5.3	---	--	--
510	FC607CMS/FC708, 4 cy Rh; CMS, mm, LSR	4.0	4	37	---	---	--	--
511	FC709; MM, Rh, LSR	1.8	46	94	---	---	12.9	20.3
513	FC726; FC703-5/Paramano, 3 cy Rh; MM	2.6	24	73	5.5	---	12.2	26.6
514	FC727; FC703/three hi suc lines, 7 cy Rh; MM	2.4	19	80	---	---	15.1	21.2
515	FC728; three comm hybs/FC708, 5 cy Rh; MM, non-OT, S-cyto	2.3	23	85	---	---	--	--
516	HM RH1; comm Rh hyb	3.5	13	50	---	---	--	--
517	HM RH2; comm Rh hyb	4.1	5	33	---	---	--	--
518	HM RH83; comm Rh hyb	4.5	1	23	---	---	--	--
519	HH32; comm Rh hyb	4.5	5	26	---	---	--	--
520	ACH184; comm Rh hyb	3.8	5	43	---	---	--	--
521	Monohikari; comm Rh susc hyb	6.1	0	2	---	---	--	--
522	ACH861350; comm Rh hyb	4.1	10	31	---	---	--	--
523	ACH895121; 3x, comm Rh hyb	4.1	4	32	---	---		

Table 1, continued

Table 1. Means for Rhizoctonia root rot assessment of germplasms in various stages of resistance development; 1991 inoculated field test

Entry	Germplasm & description[1]	Disease index[2]	Healthy roots (%)	Harvestable roots (%)	Leaf spot rating	Curly top rating	Sucrose %	Kg root/ 20' plot
--	--							
524	SR87; smooth root from E. Lansing	5.0	1	18	---	---	--	--
525	Beta 4689; comm Rh hyb	4.6	3	23	---	---	--	--
526	HM LSR88; comm LSR-Rh hyb	5.3	0	10	---	---	--	--
527	HM 1605; comm Rh susc hyb	6.0	0	6	---	---	--	--
528	Smooth root fr E. Lansing	5.4	1	15	---	---	--	--
529	Rhizosen; comm RZM hyb	5.8	0	6	---	---	--	--
530	FC705-1; high Rh resist check	2.4	26	84	6.0	---	--	--
531	FC715; FC609/FC708, 4 cy Rh; OT, mm	2.8	22	69	5.0	---	13.3	11.1
532	FC715 CMS; FC609CMS/FC708, 4 cy Rh; CMS, mm	3.1	17	57	4.5	---	--	--
533	FC712/Mono 309, 2 cy Rh; seg mm OT	4.3	12	35	5.0	---	12.7	23.1
534	Mono 309CMS/FC712, 2 cy Rh; seg mm, CMS	3.9	5	43	---	---	--	--
535	FC505CMS/FC708//FC707-2; hi recov suc exp hyb	2.9	18	64	---	---	--	--
536	1861CMS/FC708//FC707-2; hi recov suc exp hyb	2.9	19	64	---	---	--	--
537	FC607CMS/FC708, 2 cy Rh//FC709; hi recov suc exp hyb	2.4	20	79	4.8	---	--	--
538	FC505CMS/FC708//FC712; hi recov suc exp hyb	2.9	9	66	---	---	--	--
539	FC703; resist ck	2.8	22	68	---	---	--	--
540	FC710; MM, Rh	2.0	42	88	---	7.0	--	--
541	R720; 2 cy RZM from FC Rh & other lines	3.7	14	51	---	---	--	--
542	R820; 3 cy RZM fr FC Rh & other lines	3.9	8	41	---	---	--	--
543	R920; 4 cy RZM fr FC Rh & other lines	4.1	4	37	---	---	--	--
544	R020; 5 cy RZM fr FC Rh & other lines	4.4	3	37	---	---	--	--
545	Rh susc check	6.0	1	5	---	---	--	--
---	Curly top susc check; US33	---	--	--	---	5.3	--	--
---	Curly top resist check; US41	---	--	--	---	5.0	--	--
---	Leaf spot susc check	---	--	--	6.8	---	--	--
---	Leaf spot resist check	---	--	--	4.3	---	--	--
	LSD ($\underline{P}$ = 0.05)	**0.6**		**11**	**0.9**			

[1]MM = multigerm; mm = monogerm; Rh = Rhizoctonia resistant; LSR = leaf spot resistant; CTR = curly top resistant; non-OT = non O-type; S-cyto = sterile cytoplasm; cy Rh = cycles of selection for Rhizoctonia resistance; RZM = rhizomania.

[2]Disease index = 0 (no disease) to 7 (all plants dead); healthy roots = no disease or small arrested lesions; harvestable roots = roots sufficiently large and sound to be included in a grower's harvest.

Combining Ability Test of Rhizoctonia Resistant Pollinators.--R. J. Hecker (retired)

We conducted a very limited combining-ability test on four Rhizoctonia-resistant pollinators at Ft. Collins in 1991, in a disease-free field. Results are presented in Table 1.

Table 1. Means of groups of Rhizoctonia-tolerant test hybrids with common pollinators, Exp. 1, 91, Ft. Collins, CO

Pollinator of the set of hybrids & two checks	Sucrose (%)	Plot wt (kg/plot)	Gross sucrose (kg/plot)
FC707-2	14.7	19.7	2.90
FC702-7	15.5	18.9	2.93
FC712	14.5	19.8	2.87
FC709	15.0	19.2	2.88
Susceptible check (HM1605)	16.0	20.0	3.20
Tolerant check (HM RH1)	14.6	21.2	3.10
LSD (_P_ = 0.05)	**0.8**	**3.1**	**NA**

There were significant differences for sucrose among the four sets of hybrids; FC702-7 was the pollinator of the hybrid set with the highest sucrose content (15.5), but its set had the lowest average root yield (18.9 kg/21' single-row plot). The two commercial hybrid checks (HM 1605 and HM RH 1) were included for comparisons. Some of the individual hybrids within the sets of hybrids were equal to the checks.

Induction of Tetraploids of Rhizoctonia-Resistant Lines.--R. J. Hecker.

We used colchicine to convert three Rhizoctonia-resistant lines to tetraploidy. FC709(4x), FC710(4x), and FC712(4x) may be available for release in approximately 2 years.

Effect of Rhizoctonia Root Rot on Yield of Sugarbeet Varieties with Varied Degrees of Resistance.--E. G. Ruppel and R. J. Hecker (retired).

To address a concern among sugarbeet breeders and sugar producers that losses in root or sucrose yields may occur in Rhizoctonia-resistant hybrids even though disease symptoms may be mild or absent, we have conducted an experiment in 1989, 1990, and 1991 to resolve this question. We report herein the results of our third trial; results of previous tests were reported in Sugarbeet Research reports for 1989 and 1990. Materials and methods of our third trial were identical to those described in Sugarbeet Research, 1990 Report.

Disease indices (DI) and root yield are given in Table 1; DIs are compared with % sucrose, recoverable sucrose, and % purity in Table 2. As in our previous trials, early inoculation induced more root rot and decreased yields more than late inoculation. There was a direct relationship between disease severity and

yield parameters for the susceptible HM55 and the moderately resistant HH32. Reduction in root yield, % sucrose, and recoverable sucrose were not as great in ACH184, FC709, or the experimental three-way hybrid (FC505/FC708//FC712), the latter having two genomes from resistant pollinators, as compared with HM55 or HH32.

Table 1. Disease indices (DI) and root yield at harvest of five sugarbeet cultivars inoculated with *Rhizoctonia solani* 60 or 70 days postplanting in the field

	DI[2]			Root yield (t/ha)[2]		
Entry[1]	1	2	CK	1	2	CK
HM 55	6.4	4.5	0.8	5.2	23.9	47.7
HH 32	5.2	4.0	0.5	13.8	34.0	46.3
ACH 184	4.0	2.6	0.5	33.2	44.4	43.4
FC505/FC708//FC712	3.1	1.4	0.5	38.8	42.5	44.5
FC 709	1.6	1.1	0.5	36.6	35.0	35.8

[1]HM 55 = susceptible commercial hybrid; HH 32 and ACH 184 = moderately resistant commercial hybrids; FC505/FC708//FC712 = resistant experimental hybrid; FC 709 = resistant breeding line.

[2]1 = inoculated 60 days postplanting; 2 = inoculated 7 days postplanting; CK = uninoculated check.

Table 2. Disease indices (DI) and % sucrose, recoverable sucrose (t/ha), and % sucrose at harvest of five sugarbeet cultivars inoculated with *Rhizoctonia solani* 60 or 70 days postplanting in the field

	DI[2]			Sucrose (%)[2]			Recoverable sucrose[2] (t/ha)			Purity[2] (%)		
Entry[1]	1	2	CK	1	2	CK	1	2	CK	1	2	CK
HM 55	6.4	4.5	0.8	5.2	8.5	16.1	0.3	1.5	6.6	81.8	85.6	93.2
HH 32	5.2	4.0	0.5	6.7	9.2	16.7	0.7	2.3	6.8	85.9	84.1	94.1
ACH 184	4.0	2.6	0.5	11.8	13.4	17.5	2.8	4.9	6.7	86.7	91.2	94.4
FC505/FC708//FC712	3.1	1.4	0.5	13.2	15.0	15.9	4.0	5.4	6.0	88.2	92.0	92.6
FC 709	1.6	1.1	0.5	13.5	14.8	15.7	4.1	4.3	4.8	91.8	92.0	92.7

[1]See footnote for Table 1.

[2]See footnote for Table 2.

Further analyses of our data over the 3-year experiment are needed for definitive conclusions. However, from our results, we believe that there were no hidden yield losses due to *Rhizoctonia*, as measured in our inoculated nursery. Based on our data, we conclude that there is a linear relationship between disease index and the yield parameters and that our most resistant three-way hybrid was little affected by the pathogen.

EVALATION OF CONTRIBUTED LINES FOR RESISTANCE TO RHIZOCTONIA ROOT ROT (BSDF Project 903)

E. G. Ruppel and R. J. Hecker (retired)

Randomized complete block designs with five replicates were used to evaluate a total of 182 contributed lines from six companies; additionally, one company also had another test with three replicates. Rhizoctonia-resistant line FC703 and highly susceptible FC901 were included as internal controls, along with highly resistant FC705-1. The experimental design, methods, results, and statistical analyses were provided to the appropriate company breeders.

The 1991 epiphytotic was quite severe compared with the 1990 nursery, but differences between resistant and susceptible entries were quite evident and highly significant ($P < 0.0001$) in all tests. Mean disease indices (DIs; scale of 0-7, with 7 = dead) for FC705-1, FC703, and FC901 controls were 1.8, 2.3, and 5.6, respectively. Percent healthy means were 32.4, 24.7, and 0.3, whereas mean percentages of roots in classes 0 through 3 were 95.8, 86.7, and 7.1 for these controls, respectively. Mean DIs of contributor lines ranged from 2.6 to 6.4, and from 0 to 30.4% healthy roots.

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO CERCOSPORA LEAF SPOT (BSDF Project 904)

E. G. Ruppel

Randomized complete block designs with three replicates in most tests and two replicates in two special tests, as requested by the contributors, were used to evaluate 207 lines from six contributors. Internal controls included a highly susceptible synthetic and a resistant check, FC(504 X 502/2) X SP6322-0. Two-row plots were 4 m long with 56 cm between rows and a 20- to 25-cm within-row spacing. We inoculated twice (June 27 and July 3), and evaluations were made on August 23, 27, and September 3; the peak of the epiphytotic occurred around August 27.

High temperatures in August, along with our overhead irrigation to maintain high canopy humidity, helped induce a relatively severe epiphytotic by the end of the month. Disease severity was comparable to that induced in 1990, but the peak occurred about 1 week earlier. On August 27, the resistant and susceptible internal controls rated 4.4 and 7.0 (increasing disease scale of 0-10), respectively, across the nursery. In 1990 (September 4), these means were 4.1 and 6.9, respectively. Means of contributor lines on August 27 ranged from 3.0-8.0. Means of individual tests were tabulated, statistically analyzed, and sent to the appropriate contributor.

IN VITRO POLLEN TECHNOLOGY
TO ASSAY AND SELECT FOR ECONOMIC CHARACTERS IN SUGARBEET
(BSDF Project 403)

M. E. McClintock and R. J. Hecker (retired)

Our project objective was the development of in vitro techniques with pollen or other tissues to assay plants or populations for genotype or genetic worth, and to make selections for specific genetic traits. This year, we completed our in vitro studies, focusing on three areas: (a) improvement of techniques to use pollen as an assay method, (b) use of sugarbeet root or leaf tissue as assay tools, and (c) use of pollen to select for resistance to environmental stresses.

Techniques with Pollen as an Assay Method

Comparison of constant and variable environment on pollen development and subsequent germination:

Day-to-day variability in pollen germination for greenhouse-grown plants is observed frequently. To assess if this variability was due to environmental extremes encountered in the greenhouse, we compared pollen germination of two sugarbeet populations of greenhouse-grown plants with that of the same populations grown under controlled conditions in a growth chamber. Sampling results over a 15-day period in August and September are presented in Figs. 1 and 2.

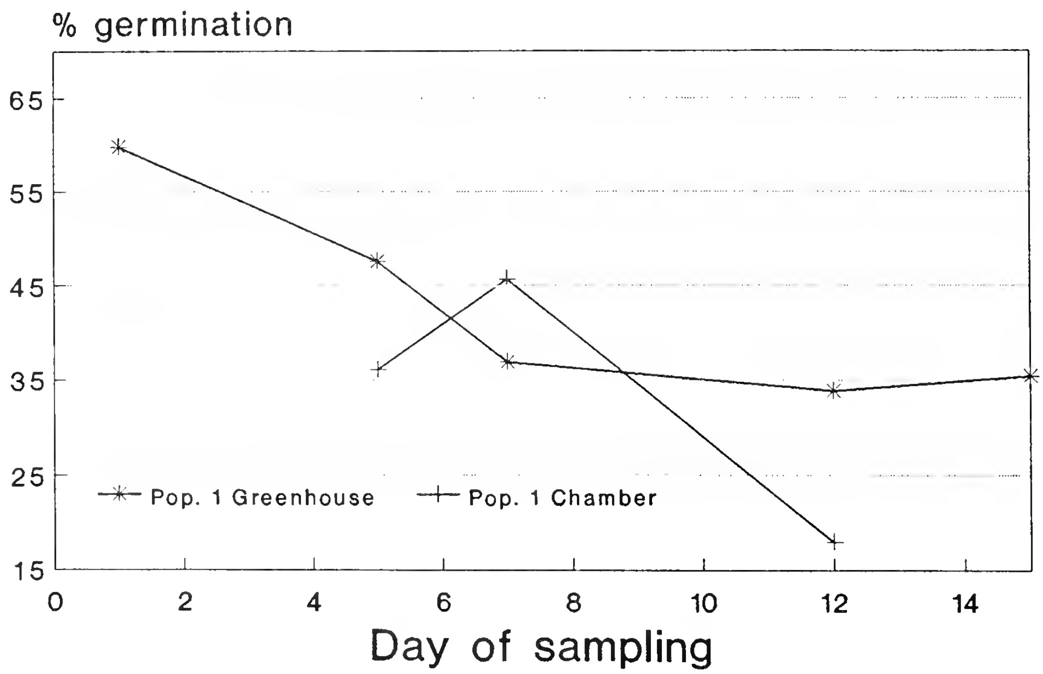

Fig. 1. Comparison of percent pollen germination of sugarbeet population #1 plants grown under variable greenhouse and constant growth-chamber conditions. Plants in the chamber began flowering earlier and had a shorter flowering period than those in the greenhouse.

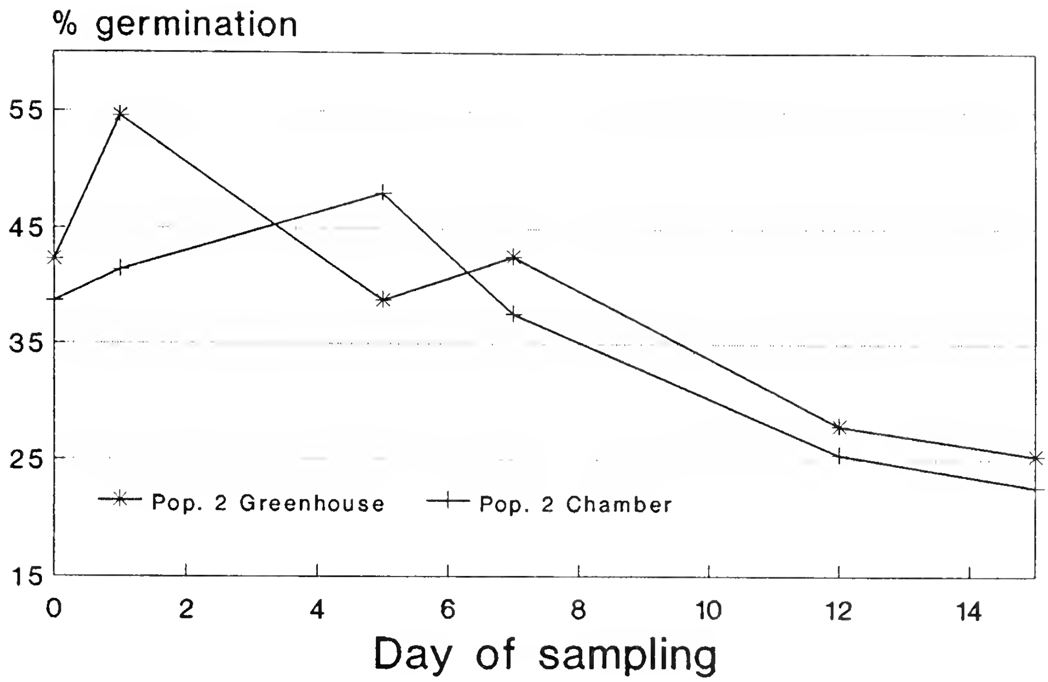

Fig. 2. Comparison of pecent pollen germination of sugarbeet population #2 plants grown under variable greenhouse and constant growth-chamber conditions.

Variances in pollen germination were not significantly different ($P = 0.05$) between the constant environment of the growth chamber and the variable environment of the greenhouse. Average germination was similar in both cases. Apparently, variability in pollen germination is due to post-collection environment, pollen treatment after collection, or an interaction of pre- and post-collection environment.

Pollen germination declined over the flowering period for the two populations. Because germination tended to increase at the end of the flowering period in earlier experiments, we could detect no clear-cut relationship between percent germination and time elapsed in the flowering period.

Studies on pollen vigor:

Shivanna, Linskens, and Cresti (Theor. Appl. Genet. 81:38-42) differentiated pollen vigor, i.e., germination in a relatively short time, from other measures of viability, such as long-term germination or the fluorochromatic reaction. In several tests, we compared pollen vigor (germination in 1 hr) and pollen viability (germination after 24 hr) for sugarbeet and various *Beta maritima* introductions.

Pollen vigor generally declined as flowering progressed in six populations of sugarbeet. Germination in 1 hr (= vigor) ranged from 1.1-18.0%, with a mean across populations of 7.0%. Standardized desiccation and storage techniques (see long-term pollen storage section) did not improve vigor.

Pollen vigor of sugarbeet populations also was compared with that of various *B. maritima* introductions. Vigor, viability (24-hr germination), and the ratio of the two were higher for *B. maritima* pollen than for sugarbeet pollen, indicating that this wild species may have a greater evolutionary need for pollen survival than does sugarbeet, which has been bred for genetic characteristics unrelated to pollen germination.

HPLC analysis of pollen sugars:

To our knowledge, there are no reports on the analysis of sugars in sugarbeet pollen. In a cooperative effort with plant physiologist Susan Martin, we developed and tested methods for sample preparation and high performance liquid chromatography (HPLC) analysis of sugars in fresh sugarbeet pollen, which we reported in Sugarbeet Research, 1990 Report. In 1991, we used our best extraction method and HPLC analysis with a Waters Sugar Pak I column to determine sugars in pollen that had been stored for 6 months.

Sucrose concentration differed for fresh and stored pollen. Sucrose concentration of 12 samples of fresh pollen averaged 9.8% by weight, whereas 18 samples of stored pollen averaged 11.0% sucrose. For both types of pollen, as a percentage of fresh weight, other components were the same: glucose and fructose, 0.1% each; and betaine, 1.6%. For all samples, root sucroses for the parent plants had been determined polarimentrically. We calculated a correlation coefficient between fresh or stored pollen sucrose and root sucrose to determine whether we could assay pollen sucrose to predict root sucrose. Although the correlation of pollen sucrose with root sucrose was slightly better with fresh than with stored pollen, the correlation coefficient was nonsignificant in either case.

Experiments to upgrade pollen viability by fractionation:

Any procedure that upgrades the quality of sugarbeet pollen may result in a desirable increase in pollen germination. We have tested several procedures and practices that affect sugarbeet pollen germination. Recently, we examined mechanical separation as a method to separate pollen into more- and less-viable fractions.

Worsley (Silvae Genet. 8:1-188) described a method of tree pollen fractionation. A compressor supplied a steady flow of air through a vertical glass tube containing pollen. Lighter, nonviable grains were carried away, leaving the more viable, "heavier" fraction behind.

We adapted Worseley's method in a simplified apparatus. We attached a compressed air source to the base of a small, fritted-glass funnel (36-mm-diameter), and placed 20 mg of humidified (3 hr) pollen in the funnel. In the funnel stopper, we fitted a glass tube to carry the lighter pollen to a collection vessel; an outlet through the top of the collecting vessel allowed air to escape (Fig. 3). Air pressure was turned on slightly. Some pollen was carried into the upper portion of the funnel, through the glass tube, and into the collection vessel. Complete separation took 30-60 sec. Most of the pollen remained in the funnel and was designated "heavier pollen." Approximately 5% was carried into the collection vessel. This pollen was designated "lighter pollen." Pollen from 11 different lines was separated with the fractionator. Pollen from lines was freshly collected from flowering greenhouse plants. Pollen from other lines had

been collected and stored for 2 yr.

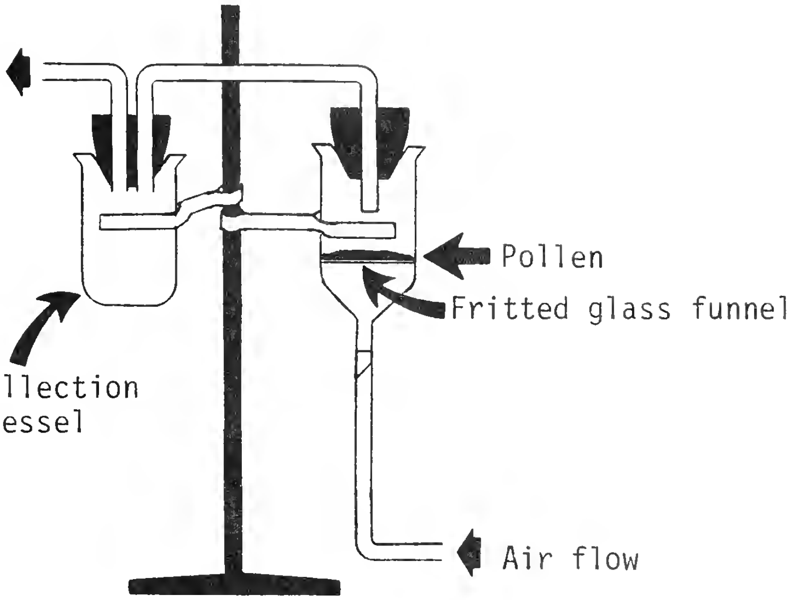

Fig. 3. Pollen fractionation apparatus.

A standard germination test was performed on the two fractions of each line. In poor quality pollen (<1% germination), the lighter and heavier fractions had equal germination. In six populations with pollen germination of more than 1%, in contrast to Worsley's findings with tree pollen, the lighter fraction always was more viable than the heavier fraction (Table 1). Highly significant differences (P = 0.01) existed among pollen lines and between fractions within lines, as determined by analysis of variance and Duncan's multiple range test. The interaction between pollen line and fraction also was highly significant.

Table 1. Mean percent germination of pollen fractions

Source	Lighter pollen	Heavier pollen
Diploid 1	22.5	18.3
Diploid 2	31.8	29.6
Diploid 3	16.1	9.7
Diploid 4	6.0	5.6
Diploid 5	25.5	23.8
Tetraploid	22.1	7.5
Average	20.6	15.7

The greatest difference in germination between fractions occurred in tetraploid pollen. Counts of normal and aborted pollen grains were made for each sample of

tetraploid pollen in an attempt to explain the difference observed. According to a *t*-test, there was no difference in the frequency of normal pollen in the twofractions of tetraploid pollen. The reason for the great difference between the lighter and heavier pollen remains unresolved.

Our fractionation method, although somewhat effective, did not upgrade sugarbeet pollen quality enough to warrant its use. High quantities of pollen are required for tests, and large losses of pollen occur due to adhesion to the inside of the collection apparatus. In most cases, pollen can be collected in small quantities only, especially when collected daily from the same source plants. Pollen loss in fractionation usually would deplete pollen quantity to an unacceptable level.

Effects of aeration and different sugars on pollen viability:

We tested three sugars in varied concentrations as an osmoticum in a germination medium. We also tested the effect of aeration on pollen germination. Although the germination medium we use is a solution of 32% sucrose in culture dishes placed on a stationary lab bench, Bamberg and Hanneman (Amer. Potato J. 68:373-379) described enhanced pollen germination and growth in actively aerated lactose compared with sucrose medium. Using Bamberg and Hanneman's methods, we tested three aeration techniques at two durations (4 or 24 hr), with lactose, dextrose, or sucrose in the medium. Aeration was accomplished by (a) a reciprocating flatbed shaker, (b) a wrist-action shaker, and (c) active bubbling of air through the medium. These techniques were compared with stationary controls.

In one experiment, samples on a reciprocating shaker had significantly higher germination than stationary controls 4 hr after pollen immersion, but there was no overall effect on total germination after 24 hr. However, in two subsequent tests, the other two methods of aeration were detrimental to pollen germination. There were no significant differences among sugars or aeration treatments, and no sugar X aeration treatment interaction was detected. Thus, our standard medium with 32% sucrose in stationary dishes is satisfactory for pollen germination studies.

Long-term storage of pollen:

In Sugarbeet Research, 1990 Report, we described the most recent results of a long-term pollen storage study. Pollen was collected in 1985, desiccated over solid $CaCl_2$ to 9% moisture, and then cryopreserved in liquid nitrogen. Pollen slowly lost viability over time. Recently, we found that $CaCl_2$ may overdesiccate small quantities of pollen. Using saturated salts (Winston and Bates, Ecology 41:232-237, 1960), other researchers obtained more consistent results than with solid $CaCl_2$. In 1991, we exposed a pollen sample to a saturated solution of $MgCl_2$ in a closed container for 2 days, drying it to a standard moisture of 9%. After 11 mo of storage, pollen desiccated over $MgCl_2$ had slightly greater viability than pollen desiccated over solid $CaCl_2$.

Sugarbeet Root or Leaf Tissue as an Assay Medium

pH of beet root tissue in relation to Rhizoctonia resistance:

We conducted an experiment to determine if there was any relationship between the pH of beet root tissue and resistance to Rhizoctonia root rot. For this test, we compared a typical root from a *Rhizoctonia*-resistant line (FC709) with a root

from a susceptible line. Each of the two halves of a root represented one replication. For each comparison, we finely grated off root tissue in four different areas: crown surface, crown subsurface, root surface, and root subsurface. Five grams of tissue was mixed with 15 ml distilled water (pH 7.0), sonicated 15 sec, and the pH recorded immediately. This test was repeated 1 week later. The pH of these tissues, regardless of resistance, ranged from 6.3-6.8. There were no significant (P = 0.05) differences in pH between root tissues of the two sugarbeet lines.

Anatomical leaf differences between Rhizoctonia-resistant and -susceptible sugarbeets:

We reported (Sugarbeet Research, 1990 Report) apparent anatomical differences between leaves of *Rhizoctonia*-resistant and -susceptible plants. We noted a higher number of dense bodies in the leaf spongy perenchyma in vegetative resistant plants compared with susceptible plants. Recently, we microscopically compared eight different lines, which varied from susceptible to highly resistant to *Rhizoctonia*. Leaves were examined at three different periods. In contrast to our preliminary report, there was no relationship between leaf anatomical differences and resistance at any sampling time.

Hypocotyl color frequency and Rhizoctonia resistance:

In onions, outer scale color relates to the degree of fungal resistance. To determine whether a similar relationship existed between hypocotyl color and Rhizoctonia resistance in sugarbeet, we conducted a study of five *Rhizoctonia*-resistant lines to determine if hypocotyl color frequency changed as disease resistance increased via several cycles of selection. We recorded hypocotyl color of seedlings from seed produced between 1976 and 1990. Whereas the disease index decreased due to additional selections for resistance, there was no consistent relationship between hypocotyl color frequency and disease index. Thus, we did not detect any linkage or genetic relationship between Rhizoctonia resistance and hypocotyl color.

Selection of Pollen under Environmental Extremes

Selection of pollen for cold tolerance:

In our study involving the chilling injury of pollen, the hypothesis was that pollen that germinated best at low temperature would effect the most fertilization, and that this functional superiority would be expressed in progeny that grew faster at low temperatures. In Sugarbeet Research, 1990 Report, we detailed procedures and testing for the fourth cycle of selection. We completed and tested the fifth cycle of selection in 1991. We have no consistent evidence that resultant progeny developed faster in the cold than did the controls.

Selection of pollen for heat tolerance:

We completed the first cycle of selection for pollen challenge and testing. Procedures were similar to those described in Sugarbeet Research, 1990 Report. Seedlings resulting from the first cycle were compared with control seedlings for their ability to withstand high temperatures.

There were no significant differences in radicle length or percent seed

germination of selected seed compared with controls. Thus, improvement in heat tolerance was not realized with one cycle of heat challenge and selection via pollen.

Selection of pollen for aluminum tolerance:

Challenge and selection of pollen for aluminum tolerance was completed through the second cycle for two different lines of sugarbeet. Parent plants were evaluated during the flowering period. There were no significant differences in pollen germination and tube length among selected lines in their ability to survive in media with high aluminum concentrations compared with controls.

The second cycle of selection produced sufficient seed for tests of aluminum tolerance. Seed of selected lines and controls were germinated in boxes containing blotter paper saturated with one of three treatment solutions: Al_2SO_4 at 20 mmol/L, K_2SO_4 (same concentration to test for any osmotic effect), and distilled water. Distilled water and the K_2SO_4 solution were adjusted to the same pH (3.3) as the Al_2SO_4 solution.

No significant differences were detected in germination or radicle length of seed from selected plants compared with the controls. Selection for aluminum tolerance via pollen challenged with high concentrations of aluminum in vitro was not effected for the two cycles of selection.

SUGARBEET RESEARCH

1991 Report

SECTION D

Northern Crop Science Laboratory, Agricultural Research Service,
U.S. Department of Agriculture, Fargo, North Dakota

Dr. W. M. Bugbee, Plant Pathologist
Dr. L. G. Campbell, Agronomist
Dr. D. L. Doney, Geneticist
Dr. C. A. Wozniak, Molecular Biologist
Dr. G. A. Smith, Research Leader, Geneticist

Cooperation:

American Crystal Sugar Co.
Colorado State University Experiment Station
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 600, 601, 610, 630 and 640) and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

CONTENTS

Abstracts of Papers Presented, Published, or Approved for Publication and Germplasm Registrations

Bugbee, W. M. 1991. A pectin lyase inhibitor from sugar beet. *Journal of Sugar Beet Research* 28:64.

A constitutive glycoprotein inhibitor of pectin lyase (PNL) was purified by affinity chromatography on a cyanogen bromide activated gel to which pectin lyase was coupled. Further purification was done by size exclusion chromatography where four fractions with estimated masses of 28, 15, 8 and 3 kD were resolved. Subunits within each fraction were resolved with polyacrylamide gel electrophoresis in sodium dodecyl sulfate. The inhibitor was in higher concentrations in a root rot resistant germplasm than in a susceptible cultivar and also higher in root than in hypocotyl or crown tissue. The inhibitor gave partial protection to cell damage caused by PNL. The inhibitor was unequally effective against PNL from *Rhizoctonia solani, Phoma betae* and *Aspergillus japonicus*.

CAMPBELL, L. G. and A. W. ANDERSON. 1991. Selection for sugarbeet root maggot resistance. *Annual Plant Resistance to Insects Newsletter* 17:15.

Sugarbeet root maggot (*Tetanops myopaeformis* Röder), the major insect pest of sugarbeet (*Beta vulgaris* L.) in the Red River Valley, traditionally has been controlled with insecticides applied at planting. Attempts to identify resistant sugarbeet genotypes have been marginally successful. Populations resulting from four cycles of mass selection had average damage ratings of 2.9, compared to 3.4 for commercial hybrids (0 = no damage to 5 = severely damaged). The most resistant lines currently in the program were originally selected in a cooperative project between USDA (Logan, Utah) and Amalgamated Sugar Co. and have since been screened in North Dakota. This material had an average damage rating of 1.9. This level of control was comparable to that obtained with insecticides at the same site. Over a 5-year period, plots with the most effective insecticide treatment had average damaging ratings of 1.6, compared to 3.6 for untreated checks. Because resistance is not simply inherited, it may be of limited commercial value. Methods of utilizing this level of resistance and/or obtaining higher levels are being explored.

CAMPBELL, L. G., A. W. ANDERSON, and K. A. PRODOEHL. 1991. Selection for sugarbeet root maggot resistance. *Agronomy Abstracts* p. 89.

Sugarbeet root maggot (*Tetanops myopaeformis* Röder) is the major insect pest of sugarbeet (*Beta vulgaris L.*) in the Red River Valley. Attempts to identify resistant genotypes have been marginally successful. Populations resulting from four cycles of mass selection had average damage ratings of 2.9, compared to 3.4 for five commercial

hybrids (0=no damage to 5=severely damaged). The most resistant lines currently in the program were originally selected in a cooperative project between USDA and Amalgamated Sugar Co. This material had a 2-year average damage rating of 1.9. This level of control was similar to that obtained with insecticides at the same site. Methods of utilizing this level of resistance and/or obtaining higher level are being explored.

CAMPBELL, L. G. and K. A. PRODOEHL. 1991. Effects of temperature and seed lot on seedling emergence. *Sugarbeet Research and Extension Reports* 21:230-231.

Poor stand establishment is a frequent problem in sugarbeet (*Beta vulgaris*) production. Percent emergence and days to 50% emergence were measured at temperatures between 10 and 25° C on a thermogradient plate. Percent emergence 14 days after planting increased rapidly between 10 and 16° C. Above 22° C there was no increase in emergence percent. Days to 50% emergence decreased sharply as temperature increased and reached a minimum at 25° C. No significant differences in emergence percent or rate of emergence were found among the 14 commercial hybrids examined. Significant year by hybrid interactions suggested that seed lots of individual hybrids differed in emergence characteristics. Relating the above results to local soil temperatures provides information needed for determining optimum planting date.

DONEY, D. L. 1991. Sugarbeet leaf lifespan. *Sugarbeet Research and Extension Reports* 21:232-235.

Characteristics of the sugarbeet canopy such as 1) a genetically alterable partitioning of the photosynthate to the root or top, 2) an excessive leaf canopy throughout much of the growing season, and 3) the continuous dying and initiation of leaves, suggests that an extension of the leaf life span would be beneficial in increasing sucrose storage and production. Tests designed to identify genetic variation showed significant genetic variation for leaf life span (green leaf duration) of the first leaves. Selection was conducted for the leaf life span of the first leaves in a heterozygous population. One cycle of selection produced new populations significantly differing in leaf life span by at least two days. These studies demonstrate that appropriate selection can alter sugarbeet life span. Future studies will focus on the effects leaf life span can have on important agronomic and physiological characteristics.

DONEY, D. L. 1991. *Beta* genetic resources: North American activities. *Proceedings of the International Beta Genetics Resources Workshop* (in press).

Beta germplasm activities in North America are coordinated by the Sugarbeet Crop Advisory Committee (CAC). This is a committee of the American Society of Sugar Beet Technologists (ASSBT) with the responsibility of providing advice, guidance and supervision of *Beta* germplasm. It works closely and coordinates all activities with the

National Plant Germplasm System (NPGS) of the United States Department of Agriculture (USDA). The Committee is composed of scientists drawn from the private, federal and state sectors. The Sugarbeet CAC provides both general and specific guidelines as well as supervision of the following *Beta* activities: 1) development of descriptor and priority descriptor lists; 2) collection and exchange; 3) preservation; 4) multiplication; 5) evaluation; and 6) enhancement of *Beta* germplasm. Since the organization of the Sugarbeet CAC in 1983, the Committee has been instrumental in the development and supervision of the following activities: 1) the development of *Beta* descriptor lists; 2) four collection expeditions to collect wild species of *Beta* in Italy, Ireland, the United Kingdom, France, Belgium, Denmark, and the USSR; 3) oversees the maintenance and preservation of *Beta* collections located at Ames, Iowa (working collection) and Fort Collins, Colorado (back-up collection); 4) developed and supervises a seed multiplication program at Logan, Utah; 5) supervises the evaluation of Beta germplasm for priority descriptors; and 6) advises on *Beta* enhancement activities. These activities have significantly increased the quality, quantity and value of the *Beta* collection. The preservation and availability of this germplasm to the user community will be a long lasting resource.

DONEY, D. L. 1991. Morphology of North Atlantic *Beta*. *Proceedings of the International Beta Genetics Resources Workshop* (in press).

Collection expeditions to Italy, Sardinia and Corsica in 1985; to England, Wales and Ireland in 1987; and to France, Belgium and Denmark in 1989; as well as earlier collections of Coons and McFarlane, have resulted in the collection and preservation of much of the North Atlantic *Beta maritima* germplasm. The systematic collection efforts of the past three expeditions succeeded in preserving most of the genetic variation present in the wild *Beta maritima* of the North Atlantic. This collection has been evaluated for morphological characteristics in field studies at Fargo, North Dakota, and in greenhouse experiments. Significant differences were found between populations for seven measured leaf characteristics. Each population differed from its nearest neighbor by at least one leaf character. Some, but not all, populations exhibited genetic variation between individual plants. Leaves of North Atlantic *maritima* are generally thicker than leaves of sugarbeet, some twice as thick. Plant life cycle changed from annual in the extreme southern part of France to biennial in Denmark. Most plants had 3-6 germs per seed ball; however, some monogerm plants were found on each side of the English Channel. Growth habit ranged from mostly erect in southern France to prostrate in Denmark; however, many populations were segregating for growth habit. As distances between populations exceeded 25 kilometers, gene frequencies significantly changed. It was determined that the distance of 25-50 kilometers was sufficient to induce the development of new ecotypes. Osmotic pressures were measured on the leaves and roots of the collection from the United Kingdom. Leaf osmotic pressures were higher, whereas root osmotic pressure was not different than sugarbeet.

DONEY, D. L. 1991. Sugarbeet Crop Advisory Committee activities. *Agronomy Abstracts* p. 205.

The Sugarbeet Crop Advisory Committee (CAC) was organized in 1983 as a committee of the American Society of Sugar Beet Technologists (ASSBT). It consists of representatives from the federal, state, and industry sectors with expertise in genetics, plant breeding, plant pathology, and cytogenetics. All geographical sugarbeet growing regions are represented on this committee. Since its organization, all *Beta* germplasm activities have been coordinated and supervised through this committee. The Sugarbeet CAC has been instrumental in the development and supervision of the following activities: 1) the development of a *Beta* descriptor list; 2) four collection expeditions to Italy, Sardinia, and Corsica in 1985; England, Wales, and Ireland in 1987; France, Belgium, and Denmark in 1989; and the USSR in 1990; 3) works closely with the *Beta* curator and oversees the *Beta* working collection located at Ames, Iowa; 4) developed and supervises a seed multiplication program at Logan, Utah; 5) supervises the evaluation of *Beta* germplasm for priority descriptors; and 6) advises on enhancement activities. The Sugarbeet CAC participates and cooperates in *Beta* germplasm activities with foreign curators, genebanks and the World *Beta* Network.

EIDE, J. D., G. A. SMITH, and C. A. WOZNIAK. 1991. Isolation of *Agrobacterium tumefaciens* from *Beta vulgaris* for enhanced transformation of sugarbeet. *Journal of Sugar Beet Research* 28:69.

Transformation of sugarbeet, *Beta vulgaris* L., with *Agrobacterium tumefaciens* is the most promising method for insertion of foreign genes into the sugarbeet genome. The number of virulent strains of *Agrobacteria* for use in sugarbeet is limited. In a search for compatible gene vectors, *Agrobacteria* were isolated from homogenized sugarbeet crown galls. Samples of serial dilutions were plated on selective media D1 or New and Kerr with or without 65 units ml^{-1} bacitracin and 30 $\mu g/ml$ streptomycin. Isolates that tested positive for 3-ketolactose were tested for virulence on sugarbeet seedlings and petiole sections. Those strains showing the greatest virulence will be candidates for disarmament and incorporation into our sugarbeet transformation program.

EIDE, J. D., G. A. SMITH, and C. A. WOZNIAK. 1991. Isolation and characterization of *Agrobacterium tumefaciens* from *Beta vulgaris* for enhanced transformation of sugarbeet. *Proceedings of the North Dakota Academy of Science* 45:37.

The use of *Agrobacterium tumefaciens* for transformation of plant genomes has been used with great success. In sugarbeets, *Agrobacterium* mediated transformation is limited due to the recalcitrant nature of sugarbeet (*Beta vulgaris*) cultures. The number of virulent strains of *Agrobacterium* for use on sugarbeet is limited. We have isolated strains of *Agrobacterium* from sugarbeet galls. Twelve galls from field grown sugarbeets were ground in 150 ml of 0.5 M potassium phosphate buffer (pH 7.5) using a Waring blender.

A 1 ml aliquot was plated onto selectable media D1 or New and Kerr containing 65 units per ml bacitracin and 30 micrograms per ml streptomycin. All *Agrobacterium* strains isolated from D1 plates were olive colored. The *Agrobacterium* isolates were separated into biovar I or biovar II by testing for utilization of lactose (3-ketoglucoside production), erythritol, and melezitose. *Agrobacterium* strains were tested for antibiotic susceptibility using Difco Dispens-O-Disc. Of the 12 antibiotics examined, only two wild strains showed susceptibility to chloramphenicol. Plasmid mini-preparations were done to look for a plasmid profile. Of the 12 strains tested, none had plasmids less than 20 kilo-base pairs. We are presently checking the wild *Agrobacterium* strains for virulence on sugarbeet petiole sections *in vitro*. In addition, virulence will be determined on sunflower, tobacco and sugarbeet plant stems *in planta*. Those showing high virulence will be incorporated into our sugarbeet transformation program.

SEILER, G. J. and D. L. DONEY. 1991. Collection of Wild Sugarbeet Species (*Beta* spp.) from Europe. *Journal of Sugar Beet Research* 28:88.

Preservation of wild sugarbeet germplasm is imperative because of the continued loss of native habitats. Cultivated sugarbeet (*Beta vulgaris* L.) is presently based on a narrow genetic base. Wild *Beta* spp. have the potential of contributing unique genes for insect and disease resistance to cultivated sugarbeet. Since 1988, sugarbeet explorations have been undertaken in five European countries: France, Denmark, Belgium, Channel Islands (Guernsey and Jersey), and the Soviet Union. Seeds from 120 collections of *B. vulgaris* L. spp. *maritima* (L.) Thell. (sea beet) were collected from France, 19 from Denmark, five from Belgium, five from Guernsey Island, and three from Jersey Island. The addition of the sea beet populations to the USDA-ARS *Beta* collection makes it the most complete in the world. Seeds from three populations of *B. corolliflora* Zoss., one population of *B. lomatogona* Fisch. et Mayer, and two populations of *B. macrorrhiza* Stev. were collected from the Soviet Union. The germplasm collected from the Soviet Union is the first seed of these wild species obtained in over 50 years. The wild sugarbeet germplasm collected is a valuable genetic resource. It's potential will be realized through systematic evaluation for specific characters.

SMITH, G. A. 1991. Development of a biopesticide targeting the sugarbeet root maggot. *Journal of Sugar Beet Research* 28:89.

The development of a biopesticide for control of the sugarbeet root maggot (*Tetanops myopaeformis* Röder) is a major project of the USDA-ARS Fargo sugarbeet unit. Three basic phases of the project have begun at the laboratory: 1) development of a bioassay, 2) identification of appropriate bacterial gene vectors, and 3) identification and isolation of the gene for use in transformation. Associated with phase 1 is the development of a laboratory rearing method for the root maggot to complete the life cycle under controlled conditions. Phase 2 includes identification and characterization of endophytic and rhizospheric bacteria. Phase 3 involves the insertion of entomocidal genes into a vector

such as *Agrobacterium* for transfer to the plant genome or the transformation of endophytic or rhizospheric bacteria for introduction to the plant and ingestion by the insect larvae. Gene products of interest are being selected for expression of high insecticidal activity with low mammalian and plant toxicities.

WOZNIAK, C. A. 1991. Occurrence of an immunorelated auxin-induced peptide in higher plant species. Proceedings of the Third International Congress of Plant Molecular Biology (in press).

A peptide of approximately 27kDa in relative molecular mass (by 2-D PAGE) was found to accumulate concommittantly with auxin-induced callus formation in *Sorghum bicolor*. This callus-associated peptide (CAP1) accumulated to become the most abundant peptide in callus tissues as observed on silver stained 2-D gels. A 2-D PAGE screen of whole plant organs detected this peptide in crown tissues, but not in anthers, ovules, seeds, leaves, leaf sheaths, roots or stems of sorghum; this peptide was greatly enhanced in crowns following whole plant treatment with natural or synthetic auxins. A second callus-associated peptide (CAP2) was found to accumulate in callus which had lost the ability to regenerate. A polyclonal antiserum raised against purified CAP1 also reacted with this 44kDa peptide on 2-D immunoblots. Both peptides also bind Con A and are considered glycoproteins. This antiserum reacted with two bands of approximately 23kDa and 27kDa in etiolated coleoptiles of sorghum and maize as well. Examination of callus of other plant species revealed the presence of an immunorelated peptide of identical size (by SDS-PAGE/westerns) in 14 of 15 grass species evaluated; six cultivars representing the three subspecies of *Oryza sativa* failed to show any immunoreaction. The tribe in which rice is placed, the Oryzeae, is often considered an arbitrary grouping of uncertain affinities. None of the 17 species of dicots or 4 species of non-gramineous monocots tested indicated the presence of any immunoreactive peptide. CAP1 is being evaluated for a possible role in auxin metabolism or binding and any taxonomic relevance it may have. EM localization and cDNA construction are being pursued.

WOZNIAK, C. A., A. W. ANDERSON, and A. MOHAMMAD. 1991. Production of gnotobiotic larvae of the sugarbeet root maggot. *Annual Plant Resistance to Insects Newsletter* 17:15.

In conjunction with *in vitro* evaluation of biopesticide products aimed at the sugarbeet root maggot (*Tetanops myopaeformis* Röder), we are currently evaluating methods for surface disinfestation of eggs which do not reduce hatch or subsequent viability of larvae. Two year-old third instars were allowed to pupate and adults mated to yield eggs for this study. Following a prewash with 0.1% Tween-20 / 0.1% Triton-X 100 for two minutes, sodium hypochlorite at 0.5% or 0.1% for three minutes, or Roccal II at 0.1% or 0.01% for five minutes, were used to disinfest eggs. Hatching ability was rated by placing eggs on sterile Whatman #3 filter discs wetted with PBS and incubated at 23 to 24° C. Percent hatch ranged from 51% to 77% for untreated, washed only, and surface sterilized

eggs with no obvious ill effects on percent hatch or viability of hatched larvae for any of the treatments. Roccal II treatments at both levels resulted in 6 to 10% of eggs retaining at least one colony forming unit when plated, whereas hypochlorite treatments yielded gnotobiotic eggs at both concentrations. Homogenization of eggs that showed no microbial growth on LBS5 plates (i.e., were surface disinfested) and plating of that homogenate indicated these eggs were devoid of any endogenous aerobic organisms capable of growing on this rich medium. These gnotobiotic larvae will be reared on axenic *in vitro* sugarbeet root cultures for evaluation of larvicidal compounds.

Papers Published Since Abstracted in Previous Report

CAMPBELL, L. G. 1991. Registration of four sugarbeet germplasms selected from the NC-7 *Beta* collection. *Crop Science* 31:237.

DONEY, D. L. and J. C. THEURER. 1990. Osmolality of L19 type sugarbeet germplasm. *Journal of Sugar Beet Research* 27:81-89.

CERCOSPORA RESISTANCE BREEDING AND RELATED RESEARCH
BSDF Project 600

RELATIONSHIP BETWEEN CERCOSPORA RESISTANCE AND YIELD IN COMMERCIAL HYBRIDS

G. A. Smith and L. G. Campbell

Plant breeders are all too aware of the difficulty of incorporating disease resistance into parental lines and hybrids while also improving, or at least maintaining, yield and quality. This task is especially difficult if the resistance is not simply inherited, as is the case with Cercospora and many other economically important diseases of sugarbeet. Although these trade-offs are widely recognized their magnitude is not well documented. Commercial yield trials are often planted at sites that avoid infection or diseases are controlled with chemicals. Under these conditions neither the value of disease resistance in the absence of control measures nor the yield reduction associated with selecting for resistance is apparent.

Forty commercial hybrids, all reported to be recommended for growing in Cercospora threat areas, were grown at Fargo, North Dakota (non-disease) and Ft. Collins, Colorado (Table 1). The field at Ft. Collins was inoculated with Cercospora and disease damage ratings were recorded on three dates (Table 2). Yield and sucrose data were taken at both Ft. Collins and at Fargo. The resistance level of the hybrids encompassed the difference between the Cercospora resistant check and the susceptible check. High correlations among the reading dates (Table 3) indicated that time of rating had only a minor effect on the characterization of resistance. The largest correlation coefficients between disease damage rating and root yield or sucrose were associated with the 23 August observations. As damage rating increased root yield and sugar concentration decreased at Ft. Collins, whereas at Fargo (in the absence of Cercospora) root yield increased as the Cercospora susceptibility increased. Regression of root yield on damage rating (23 August) indicated that for each unit increase in the rating scale there

Table 1. Commercial hybrids in Cercospora resistance experiment at Ft. Collins, Colorado and Fargo, North Dakota, 1991.

Commercial Hybrids			
HH-55	ACH-194	Maribo-410	KW-3265
HH-85	ACH-196	Maribo-862	KW-2398
HH-46	ACH-192	Maribo-875	Hilleshog-5090
HH-54	ACH-181	Maribo-897	Hilleshog-5135
HH-32	ACH-184	Ultramono	Hilleshog-8277
HH-39	ACH-176	Beta-5315	Hilleshog-8351
HH-42	ACH-198	Beta-1238	Monohikari
HH-57	ACH-185	Beta-2988	SX-1
HH-87	ACH-197	Beta-6269	SX-2
ACH-180	Maribo-403	Beta-6625	KW-3145

Table 2. Cercospora leaf spot ratings of 40 commercial hybrids, Ft. Collins, Colorado, 1991 (0 = no symptoms to 10 = complete defoliation).

	Commercial Hybrids		Controls	
Date	Mean	Range	Susceptible	Resistant
		------- disease rating -------		
23 August	6.05	4.50 - 7.00	7.00	3.75
27 August	6.62	4.75 - 7.75	7.50	5.00
3 September	6.58	5.25 - 7.50	7.00	5.25

Table 3. Correlation coefficients for Cercospora leaf spot damage ratings, root yield, and sugar concentration of40 commercial hybrids grown at Ft. Collins, Colorado and Fargo, North Dakota, 1991.

	Disease rating		Root yield		Sugar %
	27 Aug.	3 Sept.	Fargo	Ft. Collins	Ft. Collins
Disease Rating:					
23 Aug.	0.83**	0.67**	0.40**	-0.43**	-0.44**
27 Aug.	---	0.81**	0.27*	-0.34**	-0.35*
3 Sept.	---	---	0.12	-0.44**	-0.08
Root Yield:					
Ft. Collins	---	---	-0.19	---	-0.05

*,** Significant at 0.05 and 0.01 probability levels, respectively.

was a 1.3 ton/acre reduction in root yield at Ft. Collins (Figure 1). This substantiates the importance of resistance in the absence of other control measures in areas where Cercospora is prevalent. The slope of the regression line for Fargo indicated a 1.0 ton/acre increase in yield for each increment on the damage scale. This suggested that yield reduction had accompanied enhanced Cercospora resistance. The spread of the points about the regression lines indicated varying degrees of success in overcoming the negative association between yield and resistance. In the presence of Cercospora (at Ft. Collins) the more susceptible lines had lower sugar concentrations with approximately a 0.6% decrease for each increase in damage rating (23 August). When this loss is combined with the root yield reduction the economic impact of the disease is substantial. There was no obvious relationship between sugar concentration and disease resistance in the absence of the disease (at Fargo).

Without a doubt, differences between Ft. Collins and Fargo involve more than the absence or presence of Cercospora. However, the differences in patterns for Fargo and Ft. Collins strongly suggested that Cercospora resistance was a major factor. The number of hybrids and breeding programs represented strengthen the validity of these conclusions. The results demonstrated that resistance is essential if the disease is present and other forms of control are unavailable. It also provided a measure of the yield loss that has, in general, accompanied breeding for resistance. The number of hybrids with relatively high damage ratings would suggest that in many breeding programs selection for Cercospora resistance is a low priority and producers will need to rely on other control measures. The above observations are based upon one year's data. Additional testing will provide further insight into the relationship between Cercospora resistance and other important agronomic characters.

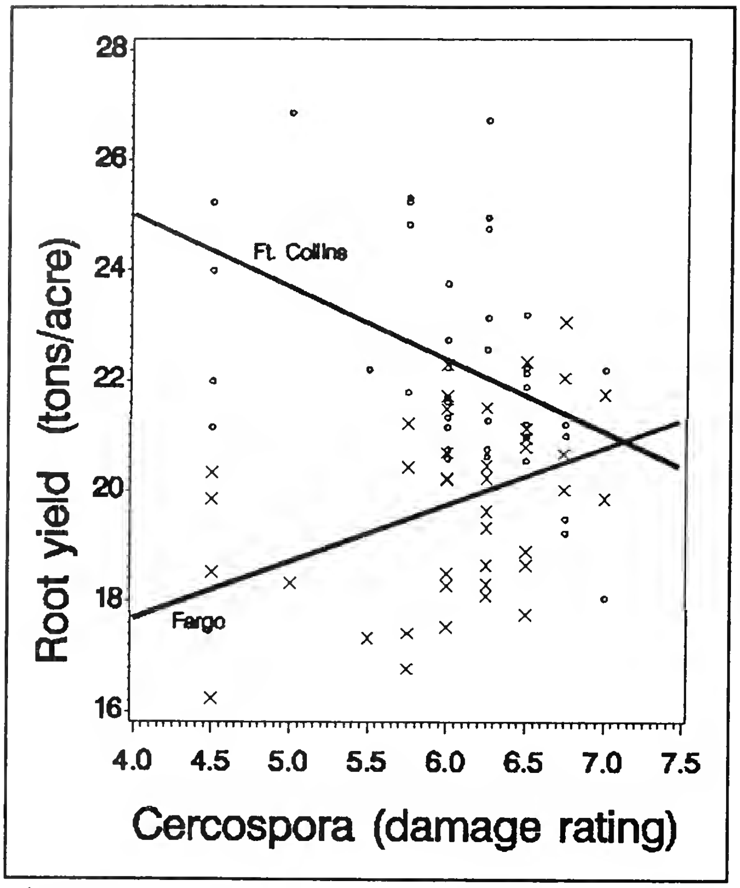

Figure 1. Cercospora resistance vs. yield at Ft. Collins, Colorado and Fargo, North Dakota, 1991.

1991 CERCOSPORA BREEDING NURSERY

G. A. Smith

Evaluations of breeding lines were carried out at the ARS nursery located on CSU land in Ft. Collins. The nursery was planted April 20 and inoculated on June 27 and July 3. Disease evaluations were conducted August 23, 27, and on September 3. The peak of the epidemic occurred about August 27. The mean leaf spot ratings of the resistant and susceptible checks on August 27 were 4.4 and 7.0, respectively. These values compared with 4.1 and 6.9 for resistant and susceptible checks, respectively, in 1990. The epidemic developed slowly but favorable conditions in August induced a good epidemic during the month.

Sixty-five entries were included in the Cercospora nursery and 34 in the curly top nursery in 1991 (Table 4). Ten entries (entries 1383-1392) included crosses between Yugoslavian lines and diploid and tetraploid versions of FC 606 CMS and FC 607 CMS. The use of FC 607 CMS at the 4x level resulted in the most resistant crosses. Other entries evaluated for leaf spot resistance included lines developed for storage rot resistance. These lines did not display high

resistance to Cercospora. The new line designated FC 907 sent to Oregon for seed increase in anticipation of release in 1992-93 will not be released. Problems in expression of the multigerm character were discovered in the field. As reported last year, this line is a Cercospora resistant multigerm pollinator developed via backcrossing with FC 607 as the recurrent parent. Further work is in progress with this line.

Table 4. Leaf spot and curly top ratings of breeding lines at Ft. Collins, Colorado and Kimberly, Idaho, respectively, in 1991.

Entry No.	Seed No.	Description/Pedigree	Ratings* Leaf Spot 8/23	8/27	9/3	Curly Top
1383	902002	NS-174,2x,MM,LSR,Yugo	5.0	5.3	4.8	7.3
1384	902003	NS-4,2x,mm,Yugo	6.8	7.5	7.0	7.0
1385	902004H2	FC607cms,2x,mm X NS-174,2x,MM, LSR,Yugo	4.8	5.0	4.5	7.7
1386	902004H3	FC607cms,4x,mm X NS-174,2x,MM, LSR,Yugo	4.3	4.3	4.3	6.7
1387	902004H4	FC606cms,2x,mm X NS-174,2x,MM, LSR,Yugo	4.0	4.5	4.8	6.0
1388	902004H5	FC606cms,4x,mm X NS-174,2x,MM, LSR,Yugo	4.8	5.0	5.0	5.7
1389	902005H2	FC607cms,2x,mm X NS-4,2x,mm,Yugo	5.3	5.8	5.8	6.3
1390	902005H3	FC607cms,4x,mm X NS-4,2x,mm,Yugo	5.3	4.8	5.5	7.0
1391	902005H4	FC606cms,4x,mm X NS-4,2x,mm,Yugo	5.5	6.0	6.3	6.0
1392	902005H5	FC606cms,2x,mm X NS-4,2x,mm,Yugo	5.5	5.3	5.8	
1393	902006	Rhizor,MM,2x,LSR,seg. for O-type, Italy	4.3	4.3	4.5	
1394	892001H2	FC607cms,mm X L19	5.3	5.8	6.5	6.0
1395	892018H2	FC606T.O. X B2007	4.8	5.0	5.0	
1396	AF90-2	F1004,M_,R_,rr,Storage rot res.	5.8	6.5	6.0	6.7
1397	AF90-3	F1005,M_,rr,Storage rot res.	6.3	7.3	6.5	7.7
1398	AF90-4	F1009,M_,R_,rr,Storage rot res.	6.3	6.5	6.8	7.3
1399	AF90-5	F1010,M_,R_,rr,Storage rot res.	6.5	7.8	7.0	6.7
1400	892003HO2	FC607cms,mm X FC609T.O.	4.5	4.5	4.5	
1401	892004HO2	FC607cms,mm X FC502/3T.O.mm	4.5	5.0	5.0	6.3
1402	892005H2	(FC506cms X FC607T.O.) X H8277	5.0	5.0	5.0	
1403	892005H3	(FC607cms X 662119HO) X H8277	6.0	6.5	5.5	
1404	892005H4	(FC607cms X FC502/3T.O.) X H8277	5.8	6.0	6.0	6.3
1405	892005H6	FC609cms X H8277	5.3	6.0	5.0	
1406	892007H2	(FC506cms X FC607T.O.) X B2007	4.8	5.0	5.0	
1407	892007H3	(FC607cms X 662119HO X B2007	5.8	6.3	5.5	
1408	892007H4	(FC607cms X FC502/3T.O.) X B2007	5.3	5.8	6.3	
1409	892007H5	(FC607cms X FC506T.O.) X B2007	5.5	5.8	5.8	
1410	892007H6	FC609cms X B2007	5.5	6.0	6.5	6.3
1411	892008H2	FC907	3.8	4.0	4.0	6.0
1412	892009H2	([FC606T.O.,rr,mm X FC701/4 97% R_,MM] X FC606T.O.,rr,mm) X FC606T.O.,rr,mm BC4	4.8	5.0	5.5	5.0
1413	892010H	H8277 X FC607T.O.	6.0	6.3	6.5	
1414	892010H2	FC607T.O. X H8277	4.5	4.5	4.5	5.7
1415	892011H	H8277 X FC609T.O.	6.3	6.5	6.8	6.7
1416	892011H2	FC609T.O. X H8277	6.0	6.3	6.0	
1417	892013H	A200 X FC607T.O.	5.5	6.0	5.8	
1418	892013H2	FC607T.O. X A200	4.8	4.5	4.3	
1419	892014H	A200 X FC609T.O.	6.3	6.8	6.5	

Table 4. Continued.

Entry No.	Seed No.	Description/Pedigree	Ratings* Leaf Spot 8/23	8/27	9/3	Curly Top
1420	892016H	B2007 X FC607T.O.	5.5	6.3	6.3	
1421	892016H2	FC607T.O. X B2007	4.3	4.5	4.8	
1422	AF90-8	891021H2;(FC504cms X FC502/2,mm) SP6322-0,LSR CK increase	4.0	3.8	4.3	6.3
1423	AF90-7	891021H;Sp6322-0,MM,R_),rr increase	4.5	4.5	4.0	
1424	892017H2	FC609T.O. X B2007	4.5	5.0	5.0	
1425	AF89-191	881019H3;FC607cms,mm X FC901,mm	5.0	5.0	5.0	5.3
1426	AF89-199	881021HO2;FC506cms,mm X FC502T.O.,mm	4.0	4.3	4.8	
1427	881022HO4	FC609cms,mm X FC607T.O.,mm	4.5	4.5	4.3	
1428	AF89-205	881022HO5;761036HO1cms,mm X FC607T.O.	4.5	4.5	4.3	5.0
1429	881022HO6	65201HO1cms,mm X FC607T.O.	4.3	4.0	4.0	
1430	881033	FC702/7	4.8	5.3	5.3	
1431	AF89-151	871028HO3;FC607cms X FC502/3T.O.	4.0	4.5	4.5	5.7
1432	AF89-157	871032HO3;FC607cms X FC506T.O.	4.5	4.8	4.8	5.7
1433	AF89-164	871034HO2;FC502cms X FC607T.O.	4.5	4.3	4.3	5.7
1434	AF89-167	871034HO6;652016cms X FC607T.O.	4.8	4.5	4.8	5.0
1435	AF89-168	871034HO7;662119HO1cms X FC607T.O.	4.0	4.5	4.5	
1436	861016HO	FC607(4x)T.O. (C3)	4.3	4.0	4.3	
1437	861016HO1	FC607(4x) (C3)	4.3	4.0	4.3	
1438	AF89-109	861019HO2;FC506cms X FC607T.O.	3.8	3.5	3.8	5.0
1440	AF89-13	861020HO2;FC607cms X 662119HO	6.5	6.0	5.0	7.7
1441	AF89-16	861025HO4;FC607cms X 64010T.O.	4.0	3.8	4.3	6.7
1442	801123HO	FC607T.O. Reselected	4.0	4.5	4.3	
1443	AF91-2	L8 91N0001	6.3	6.5	6.5	7.3
1444	AF91-3	F1006 90N0019HO	6.3	5.5	4.5	5.0
1445	821052	Yellow-leaf mutant	7.0	8.0	6.8	
1448	821051H2	LSR Check	4.5	4.5	4.8	
1449	AF90-6	891018; LSS Check	6.8	7.5	7.0	
1450		US 33, CTS Check				6.2
1451		US 41, CTR Check				4.8

*Ratings based on 0 to 10 scale, with 0 = no symptoms and 10 = complete defoliation for leaf spot and death for curly top.

IN VITRO SELECTION, REGENERATION, AND BIOPESTICIDE DEVELOPMENT RESEARCH
BSDF Project 601

G. A. Smith and J. D. Eide

ISOLATION, IDENTIFICATION, AND CHARACTERIZATION OF BACTERIA FOR POTENTIAL USE IN TRANSFORMATION OF SUGARBEET.--Routine transformation of sugarbeet using *Agrobacterium tumefaciens* has been difficult at best. Highly virulent strains

would help one's transformation efficiency when dealing with potential gene or genes products active against sugarbeet root maggot (Diptera: *Tetanops myopaeformis*). We isolated and examined wild type *A. tumefaciens* in order to find more virulent strains. *A. tumefaciens* strains were examined for virulence against sugarbeet, sunflower and tobacco. No isolated strains displayed enhanced virulence. After 41 days the positive control strain A281 produced galls in excess of 10.0 grams on sugarbeets. *A. tumefaciens* isolated from sugarbeets and type strains were characterized for antibiotic resistance profiles.

After transformation it is necessary to remove *Agrobacterium* from tissue culture. Some strains have proven difficult to remove from culture without phytotoxic effects. We examined various antibiotic activity against *A. tumefaciens*. Difco Dispens-O-Disk susceptibility test disks containing erythromycin, chloramphenicol, norfloxacin, rifampin, tetracycline, vancomycin, carbenicillin, gentamicin, cefotaxime, nalidixic acid, colistin, polymyxin b, kanamycin, streptomycin, bacitracin, ampicillin, imipenem, and nitrofurantoin were tested. The *Agrobacterium* were resistant to vancomycin, erythromycin, rifampin, gentamicin, naladixic acid, streptomycin, bacitracin, and sulfisoxazole. Antibiotics identified as bacteriostatic or bactericidal against *A. tumefaciens* were norfloxacin, carbenicillin, imipenem, cefotaxime, and tetracycline (Table 1). These antibiotics will be effective in removal of *A. tumefaciens* from transformed sugarbeet material. Extrachromosomal DNA may be involved in various antibiotic resistance. Plasmid-mini preparations of *A. tumefaciens* were examined. No plasmids less than 20 kilo-base pairs were detected.

Table 1. Antibiotic resistance of selective *Agrobacterium tumefaciens*.

	Antibiotics																		
Strain	E	C	NOR	RA	TE	VA	CB	GM	CTX	NA	CL	PB	K	S	B	AM	IMP	FD	G
B1C	R	R	S	R	S	R	S	R	S	R	R	R	R	R	R	R	S	R	R
B2A	R	R	S	R	S	R	S	R	S	R	S	S	R	R	R	S	S	R	R
B3B	R	S	S	R	S	R	S	R	S	R	R	R	R	R	R	R	S	R	R
B4KA	R	R	S	R	S	R	S	R	S	R	R	R	R	R	R	R	S	R	R
B5A	R	R	S	R	S	R	S	R	S	R	S	S	R	R	R	R	S	R	R
B6A	R	R	S	R	S	R	S	R	S	R	S	S	R	R	R	R	S	R	R
B7A	R	R	S	R	S	R	S	R	S	R	S	S	R	R	R	R	S	R	R
B8A	R	S	S	R	S	R	S	R	S	R	S	R	S	R	R	R	S	R	R
B9A	R	R	S	R	S	R	S	R	S	R	R	R	R	R	R	R	S	R	R
B10A	R	R	S	R	S	R	S	R	S	R	R	R	R	R	R	S	S	S	R
B11A	R	R	S	R	S	R	S	R	S	R	R	R	R	R	R	R	S	R	R
A281	R	R	S	R	S	R	S	R	S	R	S	S	R	R	R	R	S	R	R
EHA101	R	R	S	R	S	R	S	R	S	R	S	S	R	R	R	R	S	R	R

R=Resistant, S=susceptible, Dispens-O-Disc antimicrobial agent and disk content; E=15 mcg erythromycin, C=30 mcg chloramphenicol, NOR=10 mcg norfloxacin, RA=5 mcg rifampin, TE=30 mcg tetracycline, VA=30 mcg vancomycin, CB=100 mcg carbenicillin, GM=10 mcg gentamicin, CTX=30 mcg cefotaxime, NA=30 mcg nalidixic acid, CL=10 mcg colistin, PB=300 units polymyxin B, K=30 mcg kanamycin, S=10 mcg streptomycin, B=10 units bacitracin, AM=10 mcg ampicillin, IMP=10 mcg imipenem, FD=300 mcg nitrofurantoin, and G=300 mcg sulfisoxazole.

ISOLATION, IDENTIFICATION, AND CHARACTERIZATION OF SUGARBEET RHIZOSPHERIC BACTERIA FOR POTENTIAL USE AS VECTORS FOR ENDOTOXIN GENE INCORPORATION.--A suitable vector is needed for inserting a gene or genes detrimental to the sugarbeet root maggot. This bacterial vector must be able to colonize both the sugarbeet and/or maggot and be present in high numbers. This bacteria must be nonpathogenic, and preferably be growth promoting and/or have disease fighting capabilities. Sugarbeet rhizospheric bacteria were collected from the five following sites in the Red River Valley: Fargo, Prosper, Casselton, and Park River, North Dakota; and Crookston, Minnesota.

After three successive single colony isolations the bacteria were identified by gram staining and then using a Biolog MicroLog 2N system interfaced to a SLT instruments microplate reader. This system consists of loading the bacteria into a 96-well microplate containing 95 different carbon sources. The bacteria oxidize the substrate resulting in a 95-test color pattern. This pattern provides identification at the species and subspecies levels. *Pseudomonas* was the most predominant genera of bacteria isolated. The following species of *Pseudomonas* were identified: *P. putida* subgroup b; *P. fluorescens* subgroup a; *P. fluorescens* subgroup b; *P. fluorescens* subgroup c; *P. corrugata*; *P. marginalis*; and *P. fulva*. Other species isolated included *Enterobacter cloacae* subgroup b, *Xanthomonas maltophilia* and *Serratia marcescens*. *Xanthomonas maltophilia* and *Serratia marcescens* had previously been found to be associated with the sugarbeet root maggot. Some strains are being tested for antifungal activity (Table 2). The isolates *Serratia marcescens* and *Xanthomonas maltophilia* had antifungal activity against *Phoma betae*, *Pythium ultimum*, *Rhizoctonia solani*, *Aphanomyces cochliodes*, *Cercospora beticola* and *Botrytis cinerea*. The antifungal activities may be due to chitinase activity.

Table 2. Diameter of fungal growth in the presence of selective bacteria.

	Fungus				
Bacteria Strain	Botrytis	Rhizoctonia	Cercospora	Pythium	Phoma
91CassPS2T19 #	1	8.4	1.1	1.3	3.0
91PrPS2W17 #	1	8.4	1.2	1.1	2.3
91PrPS3Y18 $	3	8.4	2.3	1.2	1.0
91PrPS2Y23 #	1	7.5	1.2	1.2	3.0
91CassLBS5W1 %	5.5	8.4	2.5	4.0	7.1
91CassPS2Y17 #	1	8.0	1.2	1.2	3.4
Control	7.8	8.4	3.3	4.4	6.9

= *Xanthomonas maltophilia*, $ = *Pseudomonas fluorescens*, % = *Serratia marcescens*. One ml of an overnight turbid suspension of bacteria was spread and allowed to dry on a Falcon 1029, 15 X 100 petri dish containing potato dextrose agar. One cm diameter fungal plugs were placed in the middle of the petri dish. The growth of the fungus was recorded after 7 days.

Sugarbeet rhizospheric bacteria *Pseudomonas putida* and *Pseudomonas corrugata* were examined for colonization and recovery on field grown sugarbeets. Seeds of sugarbeet hybrids ACH180 and KW1745 were vacuum infiltrated with *P. putida* (PF4) and *Pseudomonas corrugata* (PC1)bacteria. The seeds were planted in the field plot at Fargo, North Dakota on May 17, 1991 in a split block with three replications. Bacteria were collected from five beets per treatment. The wash was serially diluted and plated onto PS2 and PS3 media. PS3 selected for PF4 type *Pseudomonads* while PS2 selected both PC1 and PF4 types. Selective media showed the mean colony forming units (CFU) ranged from 6.27 X 10^6 to 76.0 X 10^6 bacteria per gram fresh weight (GFW) when selected on PS2 media (Figure 1). The PS3 media selected for fluorescent *Pseudomonas* bacteria populations ranged from 1.34 X 10^6 to 20.76 X 10^6 per GFW. The August mean fluorescent *Pseudomonas* bacterial population ranges dropped to 6.55 X 10^4 to 28.25 X 10^4 per GFW for PC1 and PF4 types and 3.09 X 10^4 to 22.9 X 10^4 for PF4 types (Figure 2). This may be due to fluctuating soil moisture conditions and decreasing surface area to weight ratio. No significant differences were observed between treatments using the Duncan's multiple range test (P=0.05). The fluorescent *Pseudomonads* high bacterial density may make it a suitable cloning vector for a gene or genes detrimental to the sugarbeet root maggot. We will continue to look for and characterize suitable cloning vectors.

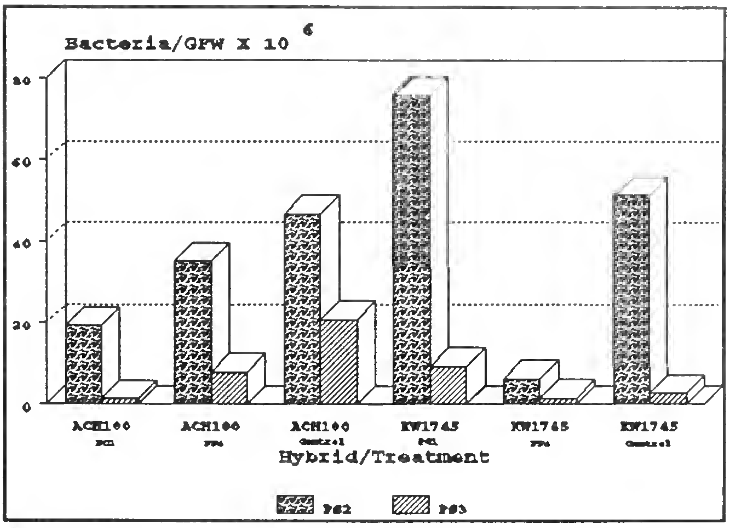

Figure 1. The number of fluorescent *Pseudomonad* bacteria per gram fresh weight of sugarbeet root recorded June 28, 1991.

A NEW *IN VITRO* SELECTION METHOD FOR CERCOSPORA RESISTANCE.--A new system for induction of *Cercospora* PR proteins and transcription products was devised. A double-sided Lutri-plate consisting of sugarbeets grown on MS media separated from *Cercospora* inoculated potato dextrose agar by a 0.2 μ polycarbonate membrane allows toxins to continuously diffuse through the membrane and induction of PR proteins. Isolation of the induced proteins and activated mRNA transcripts can be accomplished without fungal contaminants. Preparation of antibodies against these PR proteins may allow the selection of *Cercospora* resistant plants in the seedling stage. This would accelerate our *Cercospora* breeding program.

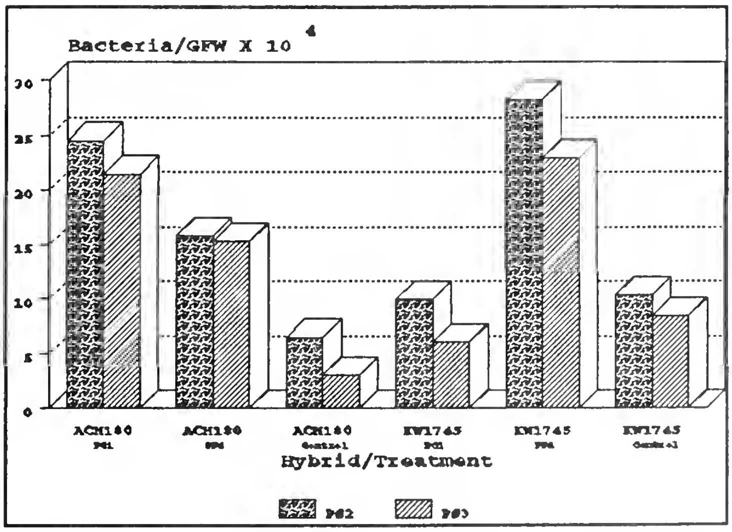

Figure 2. The number of fluorescent *Pseudomonad* bacteria per gram fresh weight of sugarbeet root recorded in August 1991.

Total protein was extracted from *Cercospora* LSS and LSR leaves. Separation by polyacrylamide gel electrophoresis found numerous polypeptides with a molecular mass of 30 and 35 kDa. These are the size ranges of the plant PR proteins chitinase and glucanase. Identification of these enzymes' roles in *Cercospora* resistance may lead to a new tool for quickly identifying fungal resistant germplasm.

***IN VIVO* SELECTION FOR CERCOSPORA RESISTANCE.**--We are examining different selection schemes for *Cercospora* resistant germplasm. The use of the *Cercospora* toxins cercosporin and CBT in selection schemes is difficult. This is due to their lengthy isolation procedures and poor solubility in aqueous solutions. Use of *Cercospora* spore suspension is difficult in the greenhouse isolators. We decided to look at the *Cercospora* toxin-mimicking chemicals paraquat and rose bengal. Greenhouse sugarbeet plants were sprayed *in vivo* with *Cercospora* paraquat and rose bengal. Plants were sprayed with 10 μg/ml, 50 μg/ml, 100 μg/ml, 500 μg/ml, or 1000 μg/ml rose bengal (A, B, C, D, E); 10 μg/ml, 50 μg/ml, 100μg/ml, 500 μg/ml, or 1000 μg/ml paraquat (F, G, H, I, J). The controls were sprayed with water Application of paraquat at 10 to 1000 μg/ml resulted in a large variation in leaf damage from 0.8 to 9.6. No significant difference was found between leaf spot susceptible (LSS) and leaf spot resistant (FC607 T.O.) lines using the Duncan's multiple range test (P=0.05). A significant difference was observed between paraquat treatments. Application of rose bengal at 10 to 1000 μg/ml resulted in leaf spot ratings of 0.4 to 1.6. No significant difference was found between lines or chemical treatments using the Duncan's multiple range tests (P=0.05). Use of rose bengal as a *Cercospora*-mimicking toxin *in vivo* is questionable. We will continue to examine these selection methods for selection of *Cercospora* resistant germplasm.

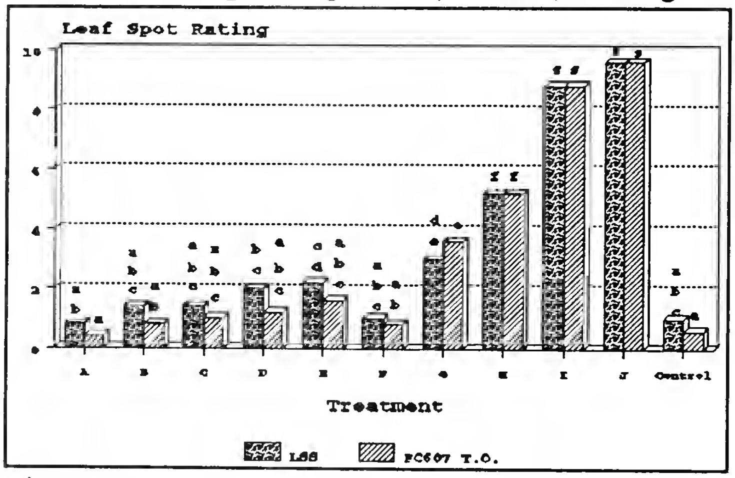

Figure 3. Leaf spot ratings based on a 0 to 10 scale. Bars with the same letters are not significant (P=0.05).

FURTHER INVESTIGATIONS OF A PECTIN LYASE INHIBITOR PROTEIN FROM SUGAR BEET

BSDF Project 610

W. M. Bugbee

Rhizoctonia has been investigated for decades by those looking for ways to reduce the damage this fungus causes to many crops; sugarbeet is but one of a long list of hosts of this pathogen. Resistant germplasm lines developed at Ft. Collins are being used by seed companies to develop resistant cultivars. In addition to genetic resistance, there are cultural practices that will help reduce losses. Although resistant cultivars and proper cultural practices comprise the entire

package of root rot control measures, the amount of protection from root rot the grower can expect depends largely on the level of resistance in the chosen cultivar. The root rot resistant cultivars that are available today have moderate levels of resistance. Higher levels of resistance are needed along with acceptable yield and quality. So the goal of this research is to gather basic information about the *R. solani*-sugarbeet association and to utilize this information to enhance genetic resistance.

AN INHIBITOR OF PECTIN LYASE.--Cell-wall-degrading enzymes which are produced by many fungal and bacterial pathogens have been recognized for quite some time now as playing a major role in pathogenesis. In the case of the isolate of Rhizoctonia worked with here, AG 2-2, the enzyme pectin lyase was the predominant cell-destroying enzyme found associated with rotted root tissue. When infected roots were extracted, the yield of pectin lyase was always less from root than from crown tissue. This led to the speculation that there might be an inhibitor of pectin lyase that was already present in the root before infection or produced in response to infection. A preformed pectin lyase inhibitor protein (PNLIP) was found and partially purified and characterized. Pectin lyase inhibitory activity was found in both an aqueous extract and in a buffered saline extract of the cell walls. Assays and analyses were performed on cell wall extracts because of ease in working with this type of preparation.

Earlier work had shown that PNLIP was most effective at pH 6.5 to 7.0. Salt (NaCl) also was found to effect the activity of PNLIP as well as PNL. The data in Figure 1 shows that PNL was most active at a NaCl concentration of 200 mM whereas PNLIP was most active at 100 mM. Therefore, inhibitory assays are being run in mixtures containing 100 mM NaCl.

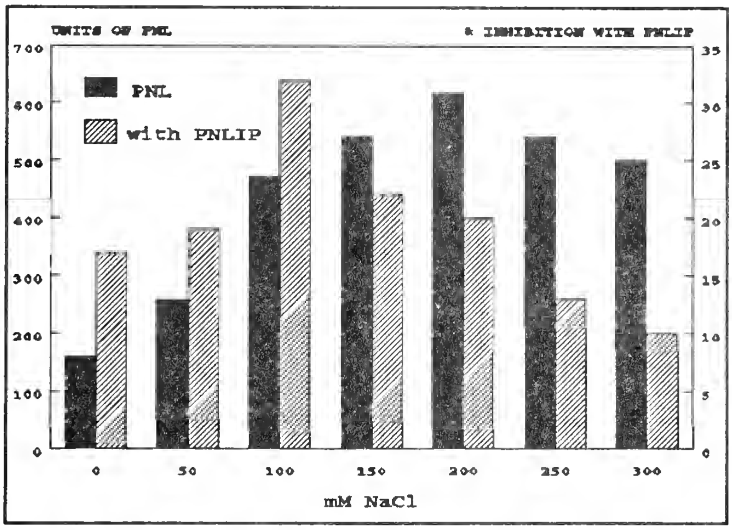

Figure 1. The effect of NaCl on the activity of pectin lyase with and without the pectin lyase inhibitor.

Assays using standard procedures showed that the type of inhibition expressed by PNLIP is uncompetitive or coupling (Figure 2). The coupling mode of inhibition is indicated if parallel lines result when the reciprocals of the substrate concentations are plotted against the reciprocals of the rate of the reaction. In coupling inhibition, the inhibitor binds to the pectin-pectin lyase complex to retard or completely prevent the formation of product, thus the rate of the enzymatic reaction is decreased.

LIVING TISSUE DAMAGE REDUCED BY INHIBITOR.--Pectolytic enzymes, including pectin lyase, destroy the semi-permeability of cell membranes. The mechanism is not known. In this experiment, slices of root tissue, washed to remove sugars from exposed cut surfaces and intercellular spaces, were exposed for 1 hour to pectin lyase with or without the inhibitor. The bathing solution was 0.1 M KPB at pH 6.8 and was assayed for the hexoses that diffused from pectin lyase damage cells into the bathing medium. The data in Table 1 shows that PNLIP was

able to protect the living tissue from full damage caused by PNL. The amount of inhibition was a function of the inhibitor:pectin lyase ratio. Less inhibition occurred at the higher level of pectin lyase. Theoretically then, when *R. solani* initiates infection by the production of relatively low levels of pectin lyase, the enzyme is met with tissue containing high levels of PNLIP in resistant tissue or low levels of PNLIP in susceptible tissues. The duration of a high inhibitor:pectin lyase ratio may characterize a portion of the sugarbeet's resistance mechanism.

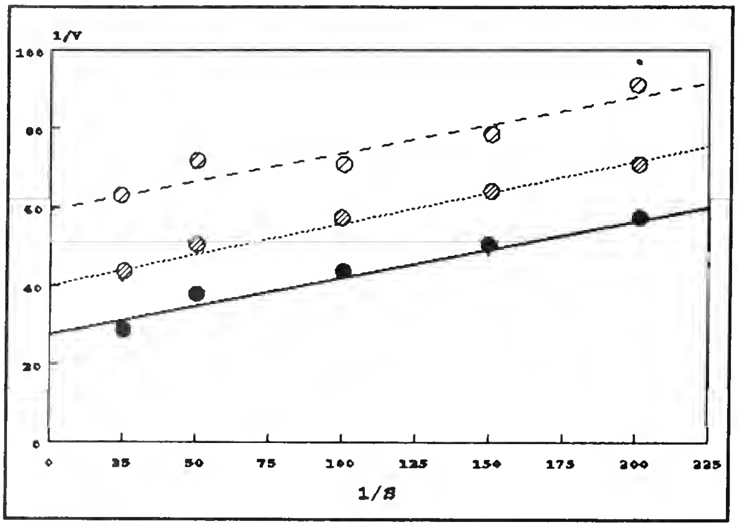

Figure 2. The reciprocals of PNL rate (1/V) vs. pectin content (1/S) of PNL alone (bottom line) and two levels of inhibitor.

Table 1. Reduction by pectin lyase inhibitor protein (PNLIP) of damage to root slices caused by pectin lyase as measured by the diffusion of sugars from root slices.

PNLIP Units	Units of Pectin Lyase: 100 — Sugars	100 — Inhibition	200 — Sugars	200 — Inhibition
	μg	%	μg	%
0 CK	35	0	75	0
80	44	0	60	20
160	5	86	28	63
320	0	100	21	72

Sugars in the diffusate were estimated from a standard curve of d-galacturonic acid. The % inhibition was based on the amount of sugars that diffused from the check slices (pectin lyase only, with no inhibitor).

IMMUNOASSAYS FOR PECTIN LYASE INHIBITOR PROTEIN.--Based on this new information, it was concluded that PNLIP has an important role in biochemical resistance to crown and root rot. To apply this information for useful purposes, we are developing an immunoassay to identify plants with high levels of PNLIP and then to correlate these high level plants with root rot resistance under field conditions. We have produced a monoclonal antibody and a polyclonal antibody to the inhibitor and are using these two antibodies in a double antibody sandwich enzyme-linked immunosorbant assay (DAS-ELISA). Using the DAS-ELISA, it was observed that extracts from petioles gave a greater reaction than root extract. This was good because it meant we could simply remove a petiole from the sugar beet, squeeze-out some juice

with a pair of pliers and proceed with the assay. Trials have shown that only 1 μl of juice is required, but in practice we take 5 μl and dilute to 1 ml with a buffer. A positive response can be detected with extracts that are diluted 800 times.

When 2-month-old plants were assayed, extract from root-rot-resistant FC 712 had a higher PNLIP value than the susceptible Ultramono but the variability was so great that the difference was significant only at the 6% level.

Petiole extracts from root-rot-resistant and susceptible plants of different ages were assayed using DAS-ELISA. The trend was for older plants (60 days old) to have higher PNLIP content than younger plants (18-46 days old). PNLIP content was detectable in the youngest plants that were tested (18 days after planting in the greenhouse). There was no statistical difference between the resistant and susceptible plants in PNLIP content in this test.

Petiole extracts from root-rot-resistant and susceptible plants grown in a growth chamber at 15° or 30° were assayed using DAS-ELISA. The PNLIP content was higher in the plants that were grown at 30° than at 15°. In this test, the PNLIP content was higher in the susceptible than in the resistant plants.

An assay using DAS-ELISA was performed on 80 greenhouse-grown plants of a root rot resistant germplasm (FC 712) and 80 plants of a susceptible germplasm (F 1010). The results showed considerable variation in both genotypes with no clear indication that the resistant genotype had the higher PNLIP content. But in another experiment, where PNLIP was expressed on a dry weight basis, the resistant FC 709 had five times more PNLIP than the susceptible F 1010 (Table 2). Furthermore, PNLIP was detected in all 10 plants of FC 709, whereas PNLIP was not detected in five of the 10 plants of susceptible F 1010. Expressing PNLIP on a dry weight basis is an accurate but tedious method. Attempts will be made to develop an accurate protocol that will not require this time-consuming step.

Table 2. Pectin lyase inhibitor activity in root rot resistant FC 709 and susceptible F 1010.

	Units of PNLIP/g dry weight		
Lines		max	min
FC 709	10	30	3
F 1010	2	10	0
t test, P = 0.001	***		

PNLIP content was determined in rotted and adjacent root tissue using DAS-ELISA. Rotted tissue had elevated levels of PNLIP and the levels decreased with distance from the rotted area (Table 3). This suggested that 1) infection stimulated the production of PNLIP or 2) bound PNLIP was released from root cell walls as a result of infection. When extracts of rotted root

tissue were assayed using a buffered pectin solution, the results also showed pectin lyase inhibitor activity but the levels were not greater than those levels found in healthy tissue, indicating that infection did not induce elevated inhibitory activity. More experiments are planned to reconcile this point.

Table 3. Estimates of relative content of PNLIP in infected root tissue using double antibody sandwich enzyme-linked immunosorbent assay.

	Absorbance at 425 nm*						
		Distance from rotted tissue, mm					
Lines	Rot	1	2	3	4	5	6
FC 712	.498	.267	.190	.270	.208	.212	.167
Ultramono	.658	.376	.315	.222	.112	.086	.158

* Higher absorbance values indicate higher PNLIP levels.

GERMPLASM RESEARCH AND PHYSIOLOGICAL SELECTION
BSDF Project 630

D. L. Doney

PRE-BREEDING.--The current gene pool from which most present-day hybrids originated is considered by many to be narrow. A review of the history of sugarbeet breeding confirms this assumption.

Improvements in sugarbeet production can be achieved by improving either harvest index or biomass production or a combination of the two. Improvement in harvest index changes the partitioning of photosynthate from top to root and will result in a larger root coupled with a smaller top. Improvement in biomass production implies an increase in both top and root yield. This can be achieved by an increase in vigor or growth as a result of an increased efficiency in either photosynthesis or metabolism. Hybrid vigor "heterosis" has been shown to be the result of increased respiration efficiency and to be more substantial between wide genetic crosses. Considering the narrow genetic background of sugarbeet, it seems probable that much of the potential hybrid vigor in the total beet germplasm is not being realized.

The objective of this research is to develop new near-sugarbeet type populations from crosses between wild relatives and sugarbeet. These near-sugarbeet type populations should have new or different growth genes from those in current sugarbeet breeding pools and, therefore, should

add additional genetic variation for growth and vigor. Near-sugarbeet type populations could be integrated into elite sugarbeet breeding pools for future improvement.

Several new populations are in the development stage as noted in Table 1. These populations are being developed as regional or sub-species type. Plant totals for each population at each stage of development are also shown in Table 1.

Table 1. Development of new near-sugarbeet type populations. Number of plants in each stage of development.

Region	Sub-species	Populations	Total plants	Male sterile plants[a]	F1 plants[b]
Belgium	*maritima*	3	76	8	36
Denmark	*maritima*	19	269	10	118
Ireland	*maritima*	39	249	13	51
TII	*maritima*	8	50	8	70
	macrocarpa	11	119	16	91
	atriplicifolia	6	35	8	70
	patula	3	11	2	9

[a] Number of genetic male sterile plants from the sugarbeet parent.
[b] Number of F_1 plants used in the first intercross.

Population TII is from the Eastern Mediterranean Region and all were annual in growth habit. Fifty plants from eight different populations within the Eastern Mediterranean Region were crossed to eight genetic male sterile sugarbeet plants to produce the F_1 population. Seventy F_1 plants (all annual) were intercrossed to produce Sib_1 seed. All annuals were eliminated from approximately 1100 Sib_1 plants, leaving 300 Sib_1 biennial plants for intercrossing in the next generation. Selection for sugarbeet type will not begin until after the second cycle of intercrossing (Sib_2).

Seven crosses (sugarbeet x *B. maritima*) made in 1986 have been selected for root type in four successive cycles. Selection for soluble solids was also included in one cycle. Resulting populations were tested in a replicated field trial in 1991 (Table 2). Stands were poor in some of the entries; however, the quality data should be reliable. The new populations were generally lower in sodium and sucrose percentage and higher in potassium, amino nitrogen, sugar loss to molasses and tare. One population (x115) is worthy of noting. Population x115 was equal to hybrid Ultramono in sugar percentage and equal to or less than the hybrids in sodium, potassium, amino nitrogen, sugar loss to molasses and tare. The low tare may be due to the round shape of beets within this population. This population was low in root yield, probably because of poor stand.

Table 2. Root yield, sucrose, sodium, potassium, amino nitrogen and sugar loss to molasses concentrations for seven populations selected from sugarbeet x wild crosses and for two sugarbeet hybrid checks.

Entry	Root yield	Sucrose	Sodium	Potassium	Amino nitrogen	Sucrose loss	Tare
	T/A	%	ppm	ppm	ppm	%	lbs
x110	8.8	13.1	430	2132	1288	2.8	12.8
x111	11.4	13.9	346	1843	1053	2.2	9.0
x112	10.4	14.2	339	1986	1115	2.3	8.9
x113	10.3	14.4	480	1848	942	2.1	8.7
x114	8.7	13.7	277	1870	1208	2.3	10.6
x115	8.9	15.3	365	1600	822	1.8	6.8
x116	10.1	13.8	345	1803	1106	2.3	8.7
Ultramono(ck)	16.1	15.8	443	1796	903	2.0	7.7
ACH 194(ck)	12.1	16.5	409	1839	844	1.9	6.9
LSD P = 0.05	3.1	0.7	88	111	41	0.2	4.4

Populations x115 and x116 will be saved for future selecting and testing. The remaining populations were judged to have insufficient genetic variation (root shape, quality factors, etc.) to warrant further selection efforts and were discarded.

EVALUATION.--As part of the Sugarbeet Crop Advisory Committee evaluation program, 60 accessions were evaluated in replicated field trials for sugar concentration and quality. Forty of the accessions were from the British Isles collection of *B. maritima* and 20 were from the Greek Islands collection of *B. maritima*. The accessions from the Greek Islands were all annual. Some bolted too early for root analyses and were discarded. Root analyses were conducted by the American Crystal Sugar Co. tare lab. The small sprangled roots made analyses difficult; however, sufficient root material was present in most plots to obtain reliable data. The sucrose percentages of these wild *maritima* types were higher than expected. They ranged from 70% to 94% of a commercial sugarbeet hybrid check. Fifteen of the accessions had sucrose percentages not significantly different from the sugarbeet hybrid. Sodium concentration was generally lower in the wild accessions, ranging from 33% to 101% of the commercial sugarbeet check. However, potassium (81% to 124%) and amino nitrogen (93% to 152%) concentrations were higher than sugarbeet.

STRESS SELECTION.--Stress selection is a greenhouse selection approach designed to identify genotypes in the seedling stage that store sucrose in the early stages of growth. Earlier studies have shown small positive increases in both sucrose concentration and root yield from one cycle of selection.

Stress selection has been conducted in several diverse populations to evaluate its potential in a broad range of germplasm. Four selection cycles in population r22 and five selection cycles in

populations 3747 and r528 have been completed. All the successive cycles of selection for each population were tested in replicated (six reps) field trials. Each field trial included two commercial sugarbeet hybrids as checks. Results of these trials are found in Table 3.

There was an increase in root yield in the first selection cycle in each population (r22, r528, and 3747) (Table 3) with no apparent root yield increase in succeeding cycles. A nonsignificant decrease in root yield occurred in the fifth selection cycle of population 3747. This population was the least heterozygous of the three populations and the slight reduction in cycle 5 may reflect inbreeding depression.

Table 3. Root yield, sucrose percentage, and total sugar yield for four successive cycles of stress selection in population r22 and for two hybrid checks.

Entry	Root yield	Sucrose	Total sugar yield
	T/A	%	lbs/A
r22s1*	13.9 b§	13.4a	3724 b
r22s2	16.2a	13.7a	4437a
r22s3	16.2a	13.6a	4390a
r22s4	16.1a	14.2a	4572a
r528s2**	9.2 b	11.7a	2145 b
r528s3	15.2a	12.3b	3754a
r528s4	13.6a	12.7b	3427a
r528s5	15.1a	12.3b	3692a
3747s1ms†	13.1 b	13.8a	3606 b
3747s2ms	16.4a	13.8a	4524a
3747s3ms	15.6ab	13.5a	4237ab
3747s4ms	16.9a	13.6a	4597a
3747s5ms	14.2ab	13.8a	3910ab

* Numbers 1-5 indicate selection cycle number.
**The first cycle not tested due to insufficient seed.
† The original population was segregating for male-sterility; each cycle was harvested on male sterile plants.
§ Means followed by the same letter are not different at P = 0.05.

An increase in sucrose percentage occurred in cycle three of population r528. Succeeding cycles had no further effect on sucrose percentage. Sucrose percentage was unaffected by stress selection in the other two populations (r22 and 3747). Since sucrose percentage was little affected by stress selection, total sugar yield reflected the effect on root yield.
All three populations experienced significant positive results in the first cycles of stress selection; however, continued selection pressure appeared to have little influence. The reason for this apparent leveling off of effects is unexplained; however, it may reflect the early fixing of genes subject to this type of selection pressure. Poor stands in tests 3 and 4 may have also influenced the results. These tests will be repeated in 1992.

GREEN LEAF DURATION.--Another means of increasing total sucrose production is to change the harvest index, i.e. partition more photosynthate to the root and less to the top. Since root/shoot partitioning is unrelated to partitioning of photosynthate in the root, any increase of photosynthate to the root should increase total sucrose production regardless of whether it affects root yield or percent sucrose.

One method of changing the harvest index is by reducing the number of leaves produced during the growing season. If the photosynthetic activity of the leaves could be extended, fewer leaves would be needed and more photosynthate could be translocated to the root.

Three cycles of divergent selection for early and late senescence of the first true leaf have been completed in a very heterozygous population. This selection pressure has significantly changed the green leaf duration of the first leaf. After three cycles of divergent selection, the first leaves lived seven days longer than the first leaves of the earliest senescing population.

These selected populations were tested in replicated field trials to evaluate the effect of extending the green leaf duration of the first leaf on root yield, sucrose percentage and canopy. This is the subject of a MS thesis and will be published more extensively later. Preliminary analyses reveal a positive effect on root yield for each successive selection cycle for longer leaf life (senescence of the first leaf) and a negative effect on root yield for successive cycles of selection for shorter leaf life. Sucrose percentage was unaffected by selection pressure in either direction. Canopy structure was also affected.

Selection for green leaf duration has been initiated in two additional populations to evaluate the influence of this selection parameter on a broader range of germplasm.

LEAF INITIATION.--During the evaluation of the green leaf duration selections above it was observed that the early senescing populations tended to initiate leaves earlier and faster while the late senescing populations tended to initiate leaves slower. It was also noted that the early senescing populations had a higher frequency of annuals than the late senescing populations. The original population was carrying the annual gene at a low frequency. It appeared that selection for early senescence favored or was linked to annualism.

Studies were initiated to evaluate the effect and relationship of leaf initiation with leaf senescence (Table 4). A highly heterozygous population was grown under controlled conditions in growth chambers. Selection was carried out for all combinations of early and late leaf initiation and leaf senescence and for fast and slow leaf growth. These selected plants were intercrossed in separate isolation chambers for each selection criterion. The resulting new populations were tested for leaf initiation, leaf senescence and leaf growth under similar growth chamber growing conditions.

Leaf initiation was measured as hours post-planting that leaves reached 5 cm in length. Leaf growth was measured as leaf length at 220, 262, 320 and 406 hours post-planting. Data are reported as the mean over all populations for the diverging selection criterion of each parameter (leaf initiation, leaf growth, and leaf senescence).

Table 4. Mean initiation and senescence (first true leaf) for progeny of divergent selections for leaf initiation, leaf growth, and leaf senescence. Data are in hours post-planting.

	Initiation		Leaf growth		Senescence	
Parameter	First	Last	Fast	Slow	First	Last
Leaf initiation	167	171**	167	171**	170	168ns
Senescence	647	667**	646	668**	662	652ns

** Significant difference at P = 0.01.

Divergent selection for leaf initiation resulted in a significant change in the leaf initiation and leaf senescence of the resulting populations (Table 5). Selection for leaf growth (fast and slow) gave similar results to selection for leaf initiation, i.e. plants selected for fast leaf growth produced progeny that were the first to initiate new leaves and were the first to senesce. Plants selected for first and last leaf senescence produced progeny that were not different in leaf initiation or leaf senescence.

Table 5. Mean leaf growth (mm) at 220, 262, 320 and 406 hours post-planting for progeny of divergent selections for leaf initiation, leaf growth, and leaf senescence.

	Initiation		Leaf Growth		Senescence	
Hours and Leaf	First	Last	Fast	Slow	First	Last
First Leaf						
220	32**	28	32**	28	30	31ns
262	60**	54	61**	53	57	58ns
320	89**	83	91**	81	86	86ns
406	115**	111	117**	108	114	112ns
Third Leaf						
262	8**	3	7**	4	5	5ns
320	51**	38	48**	40	44	45ns
406	102**	89	101**	91	96	95ns
Fifth Leaf						
320	7**	2	5	4ns	5	5ns
406	50**	34	45**	40	43	42ns
Seventh Leaf						
406	8**	3	6	6ns	6*	5

*,** Significant difference at P = 0.05 and P = 0.01, respectively.

In all measurements, progeny of selections for first leaf initiation grew faster than progeny of selections for last leaf initiation (Table 5). The same trend followed for progeny of selections for fast and slow leaf growth; however, differences were not as great as the differences for leaf initiation. Selection for either first or last leaf senescence had no effect on leaf growth.

These data confirm that leaf initiation is genetically controlled and can be altered by appropriate selection pressure. They further suggest that the earlier a leaf initiates the faster it grows and senesces. This reasoning seems logical; however, it has been observed that commercial hybrids initiate leaves faster and have a longer leaf life than these populations, suggesting that leaf initiation and leaf senescence are not completely linked. Ideally, progress for earlier leaf initiation and longer leaf life should be possible. In this study, this was not achieved. Leaf initiation appears to have a higher heritability than leaf senescence and therefore masked any attempt to select for longer leaf life. The large number of selection criteria (eight) may also have placed a restriction on potential progress. Studies are currently underway to evaluate more precisely the relationship between these selection criteria and their effects on field production.

WORLD BETA NETWORK.--The second meeting of the World *Beta* Network was held June 1991 at Braunschweig, Germany. There were about 40 participants representing 19 countries in attendance. Reports were presented on *Beta* genetic activities from the five regions (North America, Eastern Europe, Western Europe, Asia, and the Mediterranean). Based on these reports, discussions and cooperative activities were developed for the following activities.

International Data Base for Beta (IDBB): Contributions to the data base were acknowledged. Numerous requests for information have been received. The IDBB can provide information concerning *Beta* gene banks, collections, seed availability, evaluation data, accession duplication, etc. It was determined that it is not necessary to include all information currently held in the various gene banks in the IDBB, but to include information about the collections. The IDBB will periodically send reminders to update current information.

Collection: Collection gaps were identified and future cooperative efforts were proposed in India, Egypt, Turkey, Iran, Romania, Spain, and Pakistan.

Joint Seed Increase Program: The regeneration program in the first network meeting was considered a sound concept and all agreed to continue this approach.

Germplasm Evaluation: The new *Beta* Coordinating Committee was mandated to develop an international proposal for *Beta* evaluation to be presented to the IIRB council. The U.S. Sugarbeet Crop Advisory Committee evaluation program will be implemented into this global approach.

A research session on taxonomy, biosystematics, and the use of biotechniques in *Beta* germplasm research was of high interest. Some new approaches that may be useful tools were outlined.

The next meeting of the network will be held in the summer of 1993 at Fargo, North Dakota.

DEVELOPMENT OF A SUGARBEET-ASSOCIATED MICROBE CULTURE COLLECTION
BSDF Project 640

C. A. Wozniak

Various microbes present in association with plants and their insect pests are known to provide both positive and negative influence on crop yield. Some bacterial groups, primarily pseudomonads, enhance yield by providing an antibiotic effect against invading pathogens that would weaken the host plant. These groups are naturally occurring in many instances but are also being applied in furrow as growth promoting rhizospheric flora. In some cases they are being used as vectors for toxins (e.g., Cry protein of Bt) following genetic modification.

Many insects, Diptera included, have a natural microflora that must be maintained for metamorphosis and nutrition of the developing larvae. Three such microbes were implicated in a previous study of the sugarbeet root maggot based on analysis of Red River Valley samples. Interestingly, one of these insect-endogenous bacteria (IEB) is also a known rhizospheric commensal of sugarbeets and would provide a well placed vector for any strategy aimed at the root maggot. Our purpose in this project is to continually collect, identify and characterize sugarbeet-associated microbes (SAM) for our use and any other concerned sugarbeet researcher.

During the 1991 growing season, eggs and larvae of the sugarbeet root maggot (SBRM) were sampled for the presence of bacterial flora associated with this insect. Populations of third instar larvae were collected during July and August from four geographically distinct locations where sugarbeets are grown: Red River Valley (Fargo-Sabin), western North Dakota (Williston), north-central Wyoming (Powell) and the Nebraska panhandle (Bayard). SBRM were transported to the lab on ice for homogenization and sampling. External surfaces of larvae were bleached to remove casually associated microbes and soil particles. Areas of scar tissue on the root surface resulting from SBRM feeding and tunnels of host and insect exudate on peripheral feeder roots were sampled collectively as 'slime tunnels'. These were sampled directly without treatment to detect microflora associated with the feeding larvae.

Sugarbeet seed ('B1745') was disinfested with 0.5% hypochlorite, washed and planted in a mixture of pasteurized Jiffy mix and autoclaved sand in Konetainers in the greenhouse. After four weeks, roots were cleaned of loose sand and peat moss with sterile forceps, and washings of root surfaces plated in a dilution series on selective and nonselective media. Root surfaces were then disinfested with hypochlorite and internal root tissues sampled similarly to detect endophytic bacteria.

Homogenates of larvae were plated on selective and nonselective media in dilution series to estimate numbers of total bacteria as well as those species known to exist as IEB. Medium "XS" and "CT" from existing literature were chemically modified to select for *Xanthomonas maltophilia* and *Serratia spp.*, respectively, from larval, slime tunnel, rhizospheric, internal root and soil samples. These species have been previously demonstrated to be associated with SBRM collected in the Red River Valley.

In total, approximately 900 sugarbeet-associated microbes (SAM) were isolated, purified to homogeneity and stored (-80C). These isolates are currently being identified to the species level using the Biolog Microlog 3N computerized database and API 20E biochemical evaluation systems. Over 200 have been identified to species to date from the above mentioned sources.

From the four geographic areas sampled, *Xanthomonas maltophilia* (Xm) was the most commonly encountered bacterium associated with larvae of SBRM. *Serratia liquefaciens* and *S. marcescens* were found associated with larvae from the Sabin area but *Serratia spp.* were, in general, less commonly encountered in other growing areas than expected based on published data (Table 1). The other 12 species listed in Table 1 were also found occassionally in slime tunnel and greenhouse root isolations; of these *Flavobacterium gleum* was commonly encountered in slime tunnel isolations, even in areas where it was not detected in larval sampling. The presence of this species in non-inoculated roots grown in the greenhouse (Table 2) and in slime tunnels suggests that it may be a common endophyte involved in the beet-maggot interaction. We are currently devising a selective medium for *F. gleum* to more accurately assess the numbers of this species in this season's sampling of larvae and slime tunnels.

The presence of several species of *Pseudomonas* from greenhouse sampling of surface sterilized seed is particularly interesting in that the source of these bacteria is presently uncertain. Attempts to extract a similar complement of flora from surface sterilized seed ground in the lab and plated yielded a small percentage of seed carrying a portion of this flora. Current experiments are aimed at ascertaining the source of these microbes, as they are known to play a role in plant defense against fungal pathogens (and possibly insects) of the root and provide plant growth promoting substances in some cropping systems.

The most striking datum in this analysis of SAM was the omnipresence of Xm in all samples regardless of geographic origin. Xm was the most commonly encountered bacterium in larvae and slime tunnels and has also been routinely isolated from all stages of lab reared SBRM. This species, as well as the *Serratia* species, are known to produce extracellular chitinase and protease in abundance and have been applied as biocontrol agents in other cropping systems in other countries. The role that these flora, especially Xm and *F. gleum*, play in larval development and nutrition is a current area of experimentation in my laboratory.

In addition to the SAM isolated from sugarbeet growing areas, we have collected over 75 strains of Xm from other researchers for comparison. Preliminary data indicates that protein profiles of excreted and membrane bound peptides show distinct differences based on strain origin. Similarly, chitinase assays show levels of variability between strains, suggesting that selection for high and low producers from natural sources may be feasible. Type strains of several species have also been purchased from the American Type Culture Collection for use as positive contols in identification systems and biochemical comparison to SAM. A repeat sampling this summer will give us corroboration of data as well as new insights to the function these SAM play in host-parasite relationships.

Table 1. Larval isolates.*

Species	Sabin, Minnesota	Williston, North Dakota	Powell, Wyoming	Bayard, Nebraska
Xanthomonas maltophilia	7	9	14	15
Serratia liquefaciens	9	1	0	2
Serratia marcescens	1	0	0	0
Serratia sonticola	0	0	3	0
Flavobacterium gleum	0	0	3	3
Flavobacterium breae	0	0	0	1
Pseudomonas aureofaciens	0	0	0	4
Pseudomonas corrugata	0	1	0	0
Pseudomonas fluorescens	1	0	0	0
Enterobacter cloacae	1	5	2	0
Enterobacter agglomerans	0	1	0	0
Enterobacter amnigenus	0	1	0	0
Enterobacter aerogenes	0	1	0	0
Klebsiella terrigena	0	0	2	0
Alcaligenes denitrificans	0	0	3	1
Agrobacterium radiobacter	1	1	1	1

*Gram negative isolates; numbers represent positive isolations from third instar larvae.

Table 2. Greenhouse root isolates.*

Species	Rhizospheric	Endophytic
Flavobacterium gleum	3	3
Flavobacterium indologenes	1	1
Pseudomonas sp.	2	2
Pseudomonas fluorescens	5	0
Pseudomonas putida	1	0
Pseudomonas aureofaciens	0	1
Pseudomonas marginalis	0	1
Pseudomonas syringae	1	0
Pseudomonas corrugata	1	0
Enterobacter taylorae	2	0
Enterobacter agglomerans	2	2
Enterobacter amnigenus	1	0
Serratia liquefaciens	0	2
Serratia marcescens	1	0
Serratia plymuthica	0	1
Klebsiella terrigena	2	1
Xanthomonas maltophilia	0	1

*Gram negative isolates only; numbers represent positive isolations of 10 roots total.

SUGARBEET RESEARCH

1991 Report

Section E

Sugarbeet, Bean and Cereal Research Unit
Agricultural Research Service, USDA
East Lansing, Michigan

Dr. J. C. Theurer, Research Plant Geneticist
Dr. J. W. Saunders, Research Geneticist, Plants
Dr. J. M. Halloin, Plant Physiologist

Cooperation:

Michigan Agricultural Experiment Station
Michigan Sugar Company
Monitor Sugar Company

This research was supported in part by funds provided through the Beet Sugar Development Foundation
(Projects 700 and 710)

CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION

Doley, W. P. and J. W. Saunders. 1991. Effects of genotype, subculture interval and growth regulators on shoot regeneration from serially-subcultured hormone-autonomous sugarbeet (Beta vulgaris L.) callus. J. Sugar Beet Res. 28:67. (Abstract)

Shoot regeneration rapidly declines when hormone-autonomous sugarbeet callus is serially subcultured. We investigated the effects of genotype, subculture interval, BA concentration and TIBA on regeneration from calli up to 18 wk old. Calli of three genotypes were initiated from leaf disks on B1 medium (MS + 1 mg/L BA) and subcultured to various media after 3 wk growth. When calli were subcultured every 3 wk on B1, genotypes differed in rate of decline in shoot regeneration. After 15 wk on B1, more than half of EL 45/2-108 calli were still regenerating, while regeneration by calli of REL-1 and FC 607-0-20 was approaching zero. Subculture interval did not effect subsequent shoot regeneration. Regeneration from calli maintained on B1 was increased after subculture to B3 medium (MS + 3 mg/L BA). The frequency of regenerating calli and the number of shoots per callus were both enhanced by doubling the BA concentration at each subculture or by maintenance on B1 + 1 mg/L TIBA. Calli of REL-1 were more responsive than calli of FC 607-0-20 to maintenance on TIBA. Increases in shoot regeneration were greater when concentrations of both BA and TIBA were higher in subsequent medium. Calli maintained in a non-regenerating state on hormone-free medium were induced to regenerate by transfer to B3. Manipulation of shoot regeneration with BA and TIBA appears to be compatible with a model involving auxin/cytokinin ratio.

Halloin, J. M. and D. L. Roberts. 1991. A parasitic storage rot of sugar beets caused by Aspergillus fumigatus. Plant Dis. (Accepted for publication February 1991)

The fungus, Aspergillus fumigatus, was observed on rotting sugar beets incubated at warm temperatures. Research at USDA, ARS, East Lansing, Michigan established that the fungus is a parasite of live beets stored at warm (>35^{O}), but not at cool temperatures. Sugar beet lines resistant to root rots in the field caused by the fungus, Rhizoctonia solani, had some resistance to this storage rot. Sugar beets stored at 40^{O}C and then moved to cooler temperatures were no longer resistant to the storage rot at cool temperatures. Storage rots of sugar beets have been thought to be a problem mostly of heated, dead beets. This research establishes that such rots can be a problem in live beets, and that any live beets that have been heated should be processed quickly.

Hart, S. E., J. W. Saunders, K. A. Renner, and D. Penner. 1991. Initial field evaluations of sulfonylurea resistant sugarbeet. Proc. North Centr. Weed Sci. Soc. Meet. (Abstract)

Field studies were conducted at Saginaw and Bay City, Michigan, to compare the yield, sugar content, and purity of sulfonylurea resistant and susceptible sugarbeet germplasm. Herbicide efficacy studies were also conducted at Saginaw to evaluate the response of sulfonylurea resistant sugarbeet to simulated carryover residues and postemergence (POST) applications of selected sulfonylurea herbicides. In the absence of herbicides there were no differences between resistant and susceptible sugarbeets for root yield, sugar content, and clear juice purity at both locations. Nicosulfuron applied Preplant incorporated (PPI) at 9 g ai ha^{-1} had no effect on the growth of resistant or susceptible Mono Hy E-4 sugarbeets. Primisulfuron and chlorimuron applied PPI at 10 and g ai ha^{-1}, respectively, caused over 95% visual injury 6 weeks after treatment to the susceptible E-4 sugarbeet but had no adverse effects on the growth of resistant sugarbeet. POST applications of primisulfuron at 40 and 80 g ai ha^{-1} and thifensulfuron at 4 and 8 g ha^{-1} caused only slight visual injury (< 15%) to the resistant sugarbeet 4 weeks after treatment while primisulfuron applied at 160 g ai ha^{-1} caused 21% visual injury to the resistant sugarbeet. However, the resistant sugarbeet showed no visual injury symptoms from these POST treatments 8 weeks after treatment. The susceptible E-4 sugarbeet was severely injured (95% or greater) by all POST applications of primisulfuron and thifensulfuron. The sulfonylurea resistant sugarbeet grew normally at concentrations of primisulfuron and chlorimuron in the soil that killed the susceptible E-4 sugarbeet. The sulfonylurea resistant sugarbeet was tolerant to POST applications of primisulfuron at four times the field use rate and thifensulfuron at two times the field use rate. The magnitude of resistance is high enough for potential use of primisulfuron and thifensulfuron for weed control in sulfonylurea resistant sugarbeet.

Saunders, J. W., W. P. Doley, G. Acquaah, and M. H. Yu. 1991. Isoenzyme fingerprinting and in vitro shoot multiplication in Beta lomatogona Fisc. et Mey. J. Sugar Beet Res. 28:86. (Abstract)

The apomixis existing within *Beta lomatogona* Fisc. et Mey. might be useful in development of true-breeding high performance hybrid sugarbeet cultivars if it can be transferred into *B. vulgaris* L. and harnessed in breeding programs. We studied isoenzyme fingerprinting and in vitro propagation as tools to identify apomictic and interspecific progeny and to clone individual genotypes, respectively. Variation among six accessions was seen with malate dehydrogenase (MDH), isocitrate dehydrogenase, shikimate

dehydrogenase, phosphoglucomutase, and phosphoglucoisomerase, but not with 6-phosphoglucose dehydrogenase. One accession had a unique MDH pattern. Some patterns were different from those found in sugarbeet. In vitro multiplication of shoots of three accessions was achieved, starting with floral stalk axillary buds and using 6-benzyladenine as the sole growth regulator. 3.0 mg/L was the optimum concentration for overall shoot enlargement and multiplication. This is 10-fold higher than routinely found for sugarbeet. This research indicated that isoenzyme fingerprinting and in vitro shoot multiplication could be used in genetic studies with B. lomatogona and, presumably, with interspecific hybridization derivatives with sugarbeet.

Saunders, J. W., S. E. Hart, and D. Penner. 1991. Physiological and genetic basis of sulfonylurea herbicide resistance obtained from somatic cell selection. J. Sugar Beet Res. 28:23-30. (Abstract)

Publicly released clone CR1-B is a direct selection via somatic cell culture for resistance to the sulfonylurea herbicide chlorsulfuron. CR1-B was found to be 300- to 1000-fold more resistant to chlorsulfuron than source clone REL-1 in in vitro shoot culture tests. Greenhouse tests found CR1-B resistant as well to the other sulfonylurea herbicides primisulfuron and thifensulfuron, but not to imidazolinone herbicides. Both CR1-B and REL-1 exhibited similar low (10%) rates of metabolism of primisulfuron. CR1-B had acetolactate synthase (ALS) activity at least 8-fold less sensitive to inhibition by chlorsulfuron than REL-1. CR1-B is heterozygous for the resistance factor, which has been transmitted and expressed in a 1:1 fashion for 4 successive outcrosses in a stable manner. These results indicate that this sulfonylurea resistance is encoded by a dominant allele (designated Sur) that conditions an altered ALS enzyme, which is less sensitive to inhibition by the sulfonylurea herbicides.

Smucker, A. J. M. and J. C. Theurer. 1991. Dynamics of fibrous root growth for selected sugarbeet germplasm. J. Sugar Beet Res. 28:89. (Abstract)

Knowledge of the growth dynamics of fibrous root systems of sugarbeet, Beta vulgaris L., could be an important factor for enhancing production. Root activities of selected sugarbeet germplasms were quantified by the minirhizotron and micro-video camera techniques in field experiments in central Michigan. Root activities are expressed as the number of roots at the surface of minirhizotron tubes to a depth of 130 cm. Genotypes tended to show the greatest variability at approximately 55 days growth. Growth rates of the fibrous roots were greatest for the high yielding cultivar Mono-Hy-E4 and lowest for the high taproot to leaf weight ratio (TLWR) line EL-46 and the smooth root line 85700. The greatest

accumulation of fibrous roots on Mono-Hy-E4 moves down through the soil profile with the growing season. In the smooth root line, the greatest number of fibrous roots tended to stay in the top 50 cm of soil. Duration (growth vs. death) was similar over years for both Mono-Hy-E4 and the smooth root line.

Theurer, J. C. 1991. Comparison of smooth taproot sugarbeet versus standard taproot cultivars at different plant densities. J. Sugar Beet Res. 28:91. (Abstract)

Smooth root beets have the advantage of being harvested with less soil adhering to the roots, which is primarily because of the lack of the two grooves with numerous fiberous and branched roots typical of standard root type cultivars. The question arises as to the ability of smooth root types to develop adequate fibrous root systems to maintain optimal plant growth under water stress that could occur with today's desired high plant densities. Field experiments were conducted in central Michigan over three years to compare smooth root types with commercial cultivars in 28 (standard), 22, 20, 18, and 14-inch row spacings. In all experiments, smooth root lines had typically the highest root yield, and the commercial varieties had significantly higher sugar percentage at all row spacings. Smooth root lines showed parallel response to that of the commercial cultivars and no adverse effects under high density planting.

Theurer, J. C., S. A. Owens, and F. W. Ewers. 1991. Anatomy of a new sepaloid mutant flower in sugarbeet. J. Sugar Beet Res. 28:23-30.

A mutant sugar beet plant with clusters of 12-20 flowers was discovered in progeny of a male sterile plant from the NC-7 collection of *Beta* crossed with inbred NB-1. Anatomical studies revealed that most flowers had 10-25 sepals instead of the normal five. Anthers were not produced in any of the flowers. Pistil development was highly variable, some flowers had no ovules, some possessed exposed or naked ovules, and a few that appeared normal. Even though plants were subjected to large amounts of pollen from several sugarbeet sources, no seed could be obtained, and inheritance of the trait could not be determined.

Theurer, J. C. and R. C. Zielke. 1991. Field evaluation of SR87 smooth root sugarbeet hybrids. J. Sugar Beet res. 28:105-113.

Four smooth root type (SR) experimental hybrid sugarbeets (*Beta vulgaris* L.) were compared in replicated field trails (1988, 1989) with standard root type commercial hybrids and smooth root inbred lines for root and sugar yield, clear juice purity, root smoothness score, and pounds of soil harvested per ton of beets. SR hybrids had root yield and

clear juice purity readings about equal to the commercial hybrids, but they were significantly lower in recoverable sugar per ton (29 lbs.) and sucrose percentage (1.7%). Two smooth root inbred lines (85700 and SR87) had significantly the best root smoothness scores and the lowest quantity of soil per ton of roots harvested of the 10 entries evaluated. Soil harvested with SR inbreds was 26% less than for SR hybrids, while the commercial cultivars averaged about 36% more soil harvested with the beets than for the SR hybrids. Results demonstrated that SR hybrids with high yield, good quality, and greatly reduced soil tare can be produced. However, a 1% to 2% increase in sucrose percentage must be attained in current SR lines to make SR commercial varieties a reality.

Yu, M. H., L. M. Pakish, and J. W. Saunders. 1991. Association of a nematode resistance bearing addition chromosome with a recurring leaf intumescence somaclonal variation in sugar beet. Genome 34: 477-485.

Intumescent leaf variants of sugar beet (Beta vulgaris L.) were obtained through callus culture of a monosomic addition that carried resistance to Heterodera schachtii Schm. The frothy pockmarked appearance of the leaf surface was due to hyperplastic growth of the mesophyll and epidermal cells. The epidermis had many malformed stomata. Veins were underdeveloped, but protrusions beneath were pronounced. Intumescence occurred in 20.3% of the regenerated plants and it was heritable to F_1 and later progeny. Leaf intumescence is a new phenotype for Beta. About 73.5% of regenerants contained the donor somatic chromosome number, the remainder were doubled or mixoploids, with no chromosome losses apparent. The 38-chromosome intumescent plant represents a dual somaclonal variation, chromosome doubling and leaf intumescence. Progeny of the 19- and 38-chromosome intumescent plants intercrossed or pollinated by diploids or tetraploids had 9, 18, 19, 27, 28, 29, 36, 37, 38, or 39 chromosomes. All intumescent plants were aneuploids with the monosome addition. There were linkages for leaf intumescence (Li), resistance to H. schachtii (Hs), and hypocotyl color (R^{pro}) on the addition chromosome. The efficacy of Hs remained intact through the in vitro culture and succeeding crosses. The Li-bearing plants manifested depressed growth and markedly reduced seed set. Leaf intumescence was thought to be the alternative expression of galling potential of Beta procumbens Chr. Sm. germ plasm.

CHARACTERIZATION OF MONOGENIC SULFONYLUREA HERBICIDE RESISTANCE OBTAINED FROM SOMATIC CELL SELECTION

J. W. Saunders, S. E. Hart, D. Penner and K. A. Renner

Distinguishing Homozygotes from Heterozygotes. Sulfonylurea herbicide resistant hybrid cultivars could be produced using a single resistant parent if that parent were the pollinator and were homozygous resistant. Because resistance is dominant, homozygotes must be identified and distinguished from heterozygotes for production of the homozygous pollinator. The most reliable way to do this is by testcross, but this is also the most consumptive of calendar time. If dominance is complete, there are no alternatives. However, incomplete dominance may permit additional procedures to identify homozygotes that do not cost as much calendar time, as well as raising the possibility of homozygous hybrids with maximum resistance, derived from multiple resistant parents (albeit involving greater efforts to develop such a hybrid).

Previous work in our group had found qualitative evidence for incomplete dominance, based on a visual scoring of primisulfuron (CIBA-Geigy's Beacon®), damage using an S_1 population from heterozygous resistant clone CR1-B, followed by testcrossing to determine the genotypes. We have now found indirect quantitative evidence for the magnitude of incomplete dominance.

Two counterpart pairs of populations were generated: (1) susceptible vs. 100% heterozygous (L03 cms X S_1 plants of REL-1, the immediate source of CR1-B, vs. L03 cms X homozygous resistant S_1 plants of CR1-B); and (2) susceptible vs. 100% homozygous resistant (S_2 of REL-1 vs. S_1 plants from homozygous resistant S_1 plants of CR1-B). Both counterpart population pairs were evaluated against concentration gradients of three sulfonylurea herbicides: chlorimuron (DuPont's Classic®), thifensulfuron (DuPont's Pinnacle®), and primisulfuron, in both foliar sprays and reaction mixtures for the enzyme ALS (acetolactate synthase). The former would assess whole plant damage and the latter the sensitivity to enzyme inhibition by the herbicide.

For each herbicide, the 2 counterpart population pairs gave estimates of magnitudes of heterozygous and of homozygous resistance over susceptibility. Dividing the first respective magnitude into the second gives an indirect multiplicative factor for the advantage of homozygote over heterozygote, i.e., a measure of the incompleteness of dominance. This inference should be valid if significant genetic background effects are absent.

For whole plant damage, the fold magnitudes of heterozygous and of homozygous resistance over susceptibility were 57 and 144, 76 and 269, and 107 and 377 for chlorimuron, thifensulfuron, and primisulfuron, respectively. The homozygote advantage was thus

2.5, 3.5, and 3.5 fold for the respective herbicides. For the second parameter, ALS enzyme inhibition, the respective pairs of values were 21 and 157, 36 and 140, and 28 and 117 fold. The homozygote advantage was thus 7.5, 3.9, and 4.2 fold, respectively. Thus, there is a small advantage of homozygote over heterozygote. Considering that the individual plant level is more important than the population level in identification of resistant homozygotes for generating a true-breeding parental line, the enzyme assay is probably the most reliable.

Two other procedures are potentially available to distinguish homozygotes from heterozygotes at the whole plant level. These involve the in vitro exposure of either shoots or leaf discs to the herbicide. Both procedures have been used to distinguish resistant from susceptible plants, and both require less skill and equipment than the ALS enzyme inhibition test. However, we have been unable to distinguish homozygotes from heterozygotes by these tests in initial attempts, using clones previously identified by testcross. This failure might be ascribed to the low sensitivity of the in vitro methods, given the customarily high amount of experimental error experienced in tissue culture experiments. In other words, the homozygote advantage may be too small to be detected by the in vitro shoot or leaf disc herbicide test.

Agronomic Performance of Resistant and Susceptible Beets. An initial comparison of counterpart sulfonylurea resistant and susceptible populations for agronomic traits was made using near equivalent populations derived from a cross of susceptible clone TR504 with heterozygous resistant clone CR1-B. F_1 progeny segregated 1:1 for resistance and susceptibility as measured by in vitro leaf disc test. After annual segregants were rogued out, resistant and susceptible plants were isolated as two respective groups and allowed to produce seed. As CR1-B is self-fertile, much of this was self seed. F_2 seed was bulked in each isolation. There were at least twenty F_1 plants in each category. Four rep, 2-row tests were conducted at 2 locations in 1991. There were four entries: Mono Hy E4 as a general reference standard, the susceptible F_2 population, the F_2 population from the heterozygous resistant F_1 segregants (containing 25% F_2 susceptible segregants), and the preceding population treated with a sulfonylurea herbicide before thinning to eliminate susceptible segregants.

We can conclude from the test results in Table 1 that the presence of the resistance alleles caused no adverse response in agronomic performance. There was a significant increase in sugar per acre in the Bay City test when the resistant population was sprayed with primisulfuron. This should not be interpreted as due to extra weed control because all plots were kept weed-free throughout the test.

Field Evaluations of Sulfonylurea Resistant Sugarbeet. Herbicide efficacy studies were conducted at the Bean and Beet research farm at Saginaw, to evaluate the response of resistant F_2 beets from the cross TR504 X CR1-B to simulated carry-over residues as well as to postemergence (POST) applications of several sulfonylurea herbicides. Primisulfuron and chlorimuron applied pre-plant incorporated at 10 and 3 g/ha of active ingredient, respectively, (to simulate a 25% carry-over) caused over 95% visual injury 6 weeks after treatment to the susceptible Mono Hy E4 beet, but had no adverse effects on the growth of the resistant beets. POST applications of primisulfuron at 40 and 80 g ai ha^{-1} and thifensulfuron at 4 and 8 g ha^{-1} caused only slight visual injury (< 15%) to the resistant sugarbeet 4 weeks after treatment, while primisulfuron applied at 160 g ai ha^{-1} caused 21% visual injury to the resistant sugarbeet. However, the resistant sugarbeet showed no visual injury symptoms from these POST treatments 8 weeks after treatment. The susceptible E-4 sugarbeet was severely injured (95% or greater) by all POST applications of primisulfuron and thifensulfuron. The sulfonylurea resistant sugarbeet grew normally at concentrations of primisulfuron and chlorimuron in the soil that killed the susceptible E-4 sugarbeet. The sulfonylurea resistant sugarbeet was tolerant to POST applications of primisulfuron at 4 times the field use rate and thifensulfuron at 2 times the field use rate. The magnitude of resistance is high enough for potential use of primisulfuron and thifensulfuron for weed control in sulfonylurea resistant sugarbeet.

TABLE 1: Agronomic Performance of Sulfonylurea Resistant and Susceptible Sugarbeet Lines in the Absence of Herbicides.

Location	Sugarbeet line		Yield	Sugar	C.J.P.[1]
			(kg/ha)	(%)	(%)
Saginaw	Susceptible	Mono Hy E4	40200	18.5	95
		TR504 X CR1-B progency	35600	17.0	93
	Resistant	Non-Treated	33400	16.9	94
		10 g ai ha^{-1} primisulfuron[2]	35000	16.5	93
	LSD (0.05)		3800	0.9	2
Bay City (Nematode Infested Site)	Susceptible	Mono Hy E4	21500	15.2	95
		TR504 X CR1-B progeny	11500	14.0	93
	Resistant	Non-Treated	12700	14.3	94
		10 g ai ha^{-1}	14600	13.9	94
	LSD (0.05)		2600	0.4	2

[1] C.J.P. = Clear Juice Purity

[2] Plots sprayed with 10 g ai ha^{-1} of primisulfuron prior to thinning to eliminate susceptible segregates.

ATTEMPTING TO OBTAIN IMIDAZOLINONE HERBICIDE RESISTANCE

J. W. Saunders, S. E. Hart, and D. Penner

In Michigan, most sugarbeets follow dry beans in the rotation. With the withdrawal of Amiben® from the list of available herbicides, growers have started using American Cyanamide's Pursuit®. Imazethapyr, an imidazolinone herbicide, is the active ingredient of Pursuit. Carry-over of Pursuit from dry beans into sugarbeet crops has caused damage in commercial fields, and Pursuit can be considered a more significant problem for sugarbeets in Michigan than the sulfonylurea herbicides for which we have found resistance. Both the imidazolinones and the sulfonylureas inhibit aceto-lactate synthetase (ALS).

Nearly 100 survivors have been recovered from plating out unmutagenized REL-1 cell clusters onto lethal doses of imazethapyr, the active ingredient in Pursuit. However, none began as clean callus colonies like the sulfonylurea resistant colony obtained 5 years ago. These recent survivors quickly turned green and regenerated shoots almost immediately. After in vitro shoot multiplication, shoots were challenged in vitro with normally lethal concentrations of imazethapyr. All died.

Our tentative conclusion is that these survivors relied somehow on a partly differentiated structure to survive herbicide toxicity. From leaf disc callusing to liquid suspension culture to cluster plate-out, all media contain the concentration of benzyladenine optimal for shoot regeneration. Perhaps the suspension culture is not homogeneously undifferentiated. This suggests that modifying the media to retard shoot regeneration might reduce or eliminate this kind of response. The risk with that approach is that recovery of shoots, and thus whole plants, from surviving callus might become more difficult. Another thought is that if the escapes are derived from the coarsest size fraction of the suspension, then use of a finer sieve might prevent the problem.

One genetic consideration must be dealt with. If there is a single active ALS gene in sugarbeet, obtaining a resistance to the imidazolinone herbicides that is not cross-resistant to the sulfonylureas, would make it highly difficult to sexually combine the new imidazolinone resistance with the existing sulfonylurea resistance in homozygous condition, because they would be on opposing alleles. One solution to this is to start with a homozygous sulfonylurea resistant genotype that is tissue culture friendly. Then, if imidazolinone resistance is obtained, it most likely will be obtained by a second "hit" on the ALS gene, and it would be easy to then produce doubly-resistant homozygotes for use as a pollinator for hybrids, assuming the second mutation did not undo the first.

EVALUATION OF SUGARBEET SMOOTH ROOT GERMPLASM - 1991

J. C. Theurer

Evaluation of SR87 and SR80 Experimental Hybrids. SR87 is a high yield smooth root type sugarbeet breeding line that was released to the industry in 1990. SR80 is a line that showed less smoothness of root, but significantly higher sucrose content than SR87 in preliminary field evaluation tests for three years. Seed of SR80 and experimental hybrids, with this line as a pollinator, were produced in Oregon in 1990 in preparation of a field test to evaluate the combining ability of SR80 in preparation for possible release of this line to the sugarbeet industry.

An experiment was conducted in 1991 to compare the agronomic performance of SR87 and SR80 with two commercial cultivars, MHI E4 and ACH 185, and to observe the combining ability of the SR lines when they were each crossed to five CMS lines. Three of the CMS lines were used in common in crosses to both SR87 and SR80. The fourteen entries were planted in two 28" row plots, 30 feet in length in a random block design of six replications. Individual beets were thinned to a spacing of 8-12 inches within the row. All beets in a plot were harvested and weighed for root weight and a 15 beet sample was selected for laboratory analysis to determine sucrose percentage and clear juice purity. These analyses were performed in the Michigan Sugar Company Research Lab at Carrollton using standard methods. A subjective smoothness of root score on a scale of 1 (very smooth) to 4 (grooved/rough) was given to each plot by observing each beet as it fell from the grab rolls into the weighing basket on the harvester. Data were analyzed using MSTAT statistical programs.

Results

Sugar yield, root yield, sucrose percentage, clear juice percentage and smoothness of root scores are given in Table 1. SR87 was equal to the commercial varieties in recoverable sugar per acre (RWSA) and SR80 was significantly lower. The experimental hybrids tended to exceed MHI E4 and ACH 185 in RWSA with 576CMS x SR80 and H23CMS x SR87 significantly out yielding the commercials. The commercial varieties were better than the SR lines or their hybrids in recoverable sugar per ton (RWST). The RWST for SR80 was significantly higher than for SR87. All of the hybrids except one produced more tons of beets per acre than the commercials. They averaged 4.8 tons more root weight. The root yield of the SR lines was equal to that of the checks. HMI E4 and ACH 185 significantly exceeded all of the SR and experimental hybrids in sucrose percentage. SR87 had the lowest sucrose percentage of the fourteen entries with a reading of 15.4%. SR80 was significantly higher in sucrose than SR87 (almost 1%) but was 0.9% lower than MHI E4 and 2.0% lower than ACH 185. Marked differences were noted in the effect of the CMS

parentage of the experimental hybrids for sucrose percentage and RWST. The 576CMS crosses had the highest values. In general the SR inbreds and hybrids were similar to the commercial varieties in their clear juice purity. SR87 had the lowest smooth root score. SR80 also was significantly better in root score than the commercial varieties and most of the experimental SR hybrids.

AGRONOMIC EVALUATION OF SMOOTH ROOT RHIZOCTONIA ROOT ROT NURSERY SELECTIONS

J. C. Theurer

Polycross progenies of individual Rhizoctonia tolerant beets selected from smooth root breeding lines grown in the 1989 disease nursery were planted in a replicated field experiment in 1991 to evaluate their agronomic performance. The field test consisted of 32 SR selections and two check varieties, MHI E4 and ACH 185. Individual field plots consisted of two 28" rows 30 feet in length in a randomized block with 3 replications. All beets in the plot were weighed for root yield and a sample of 15 roots was taken for sucrose percentage and purity determinations. At harvest, a score for smoothness was given for each plot by observing the beets as they fell from the harvester grab rolls into the weighing basket.

Results

Most SR progenies were equal to the checks in RWSA, but all SR progenies were significantly lower in RWST (Table 2). The SR entries ranged from 22.7 to 29.5 tons per acre compared to 22.3 tons averaged by the checks. The SR progenies averaged 4 tons more per acre with the highest yielding progeny exceeding the average of the commercials by 7 tons. Thus the SR material has outstanding root yield capability. Sucrose percentage of the SR progenies ranged from 1.3% to 3.0 less than the checks. Eleven of the 32 SR progenies had equal CJP percentage with the checks, but 21 were significantly lower in purity. A wide range was noted in the smooth root scores of the RS material. Twenty one of the progenies had significantly smoother roots than the checks. The best performing progenies will be selected, crossed with high sugar lines to increase their sucrose content, and then will be reselected for disease resistance.

Table 1. RWSA, RWST, tons/acre, sucrose percentage, clear juice purity percentage and root smoothness score for SR87, SR80, 10 experimental SR hybrids and two commercial varieties. B&B Farm, Swan Creek, MI. 1991.

Variety Name	RWSA	RWST	T/A
1 MHI E4	5098 EF*	254.2 B	20.07 DEF
2 ACH185	5367 CDEF	271.8 A	19.76 ED
3 H23CMS x SR80	5653 ABCD	230.8 EF	24.49 B
4 657CMS x SR80	5700 ABCD	230.3 EF	24.78 AB
5 576CMS x SR80	6106 A	245.5 C	24.90 AB
6 6926/EL48CMS x SR80	5597 ABCDE	223.4 FG	25.07 AB
7 BMC-CMS x SR80	5157 DEF	232.4 DE	22.22 CD
8 H23CMS x SR87	5915 AB	219.6 G	26.98 A
9 EL36CMS x SR87	5635 ABCDE	220.2 G	25.60 AB
10 576CMS x SR87	5675 ABCD	239.6 CD	23.71 BC
11 657CMS x SR87	5483 BCDE	223.2 FG	24.58 B
12 FC607CMS x SR87	5726 ABC	229.2 EF	24.98 AB
13 SR87	4832 FG	220.6 G	21.88 CDE
14 SR80	4521 G	236.5 DE	19.14 F
Mean	5462	234.1	23.44
lsd (0.05)	545	8.5	2.25
CV	8.66	3.13	8.33

Variety Name	Sucr%	CJP %	Root Sm Score
1 MHI E4	17.52 B	94.19 ABC	3.25 A
2 ACH185	18.65 A	94.22 ABC	3.17 AB
3 H23CMS x SR80	16.18 EFG	93.71 ABCD	2.67 CDE
4 657CMS x SR80	16.22 EF	93.49 BCD	2.75 ABC
5 576CMS x SR80	16.74 C	94.87 A	2.92 ABC
6 6926/EL48CMS x SR80	15.85 FGH	93.24 BCD	2.83 BCD
7 BMC-CMS x SR80	16.30 DE	93.65 BCD	3.17 AB
8 H23CMS x SR87	15.72 HI	92.89 D	2.17 F
9 EL36CMS x SR87	15.68 HI	93.14 CD	2.42 EF
10 576CMS x SR87	16.59 CD	94.18 ABC	3.00 ABC
11 657CMS x SR87	15.84 GH	93.22 BCD	2.50 DEF
12 FC607CMS x SR87	16.22 EF	93.29 BCD	2.50 DEF
13 SR87	15.40 I	94.16 ABC	1.75 G
14 SR80	16.32 DE	94.42 AB	2.25 F
Mean	16.37	93.76	2.67
lsd (0.05)	0.37	1.20	0.41
CV	1.94	1.11	13.44

* Duncan's Multiple Range test - values with same letter suffix are not significantly different at the 0.05 level.

Table 2. Sugar yield, root yield, sucrose percentage, CJP percentage and root smoothness score for 32 SR Rhizoctonia tolerant polycross progenies. B&B Farm, Swan Creek, MI. 1991.

Variety	Description	RWSA	RWST	T/A	SUCR%	CJP %	Root SmSc
MHE4	MHE4	5391	247.0	21.86	17.12	94.01	3.50
ACH185	ACH185	5969	261.8	22.81	18.15	93.84	3.17
WC90729	SR87	5412	205.4	26.39	15.01	92.18	1.67
WC90016	SR80	5443	220.7	24.72	15.67	93.25	2.50
90H22	UR88H6-1 (8549-58)	5531	203.6	27.20	15.19	91.23	3.00
90H24	UR88H11-17 (85700)	5301	202.8	26.13	14.90	91.96	3.00
90H28	UR88H13-5 (85700)	5207	214.0	24.35	15.45	92.55	2.33
90H30	UR88H13-21 (85700)	5319	191.0	27.86	14.72	90.07	2.50
90H32	UR88H45-2 (8549-10)	5548	216.1	25.68	15.62	92.48	2.67
90H33	UR88H49-4 (8549-18)	4502	198.0	22.67	14.87	91.06	2.67
90H37	UR88H56-2 (8549-38)	6000	207.4	28.99	15.24	91.87	2.00
90H38	UR88H56-6 (8549-38)	5398	212.8	25.43	15.48	92.24	2.83
90H39	UR88H56-16 (8549-38)	5293	212.9	24.88	15.40	92.48	2.83
90H40	UR88H57-3 (8549-4)	5735	208.6	27.52	15.07	92.63	2.67
90H41	UR88H60-1 (8549-51)	4947	201.0	24.62	14.98	91.35	2.50
90H43	UR88H64-1 8549-59)	5774	209.8	27.54	15.46	91.70	2.50
90H44	UR88B1-2 (86B19-3)	6106	214.2	28.52	15.57	92.23	3.00
90H45	UR88B1-18 (86B19-66)	5332	206.0	25.90	15.03	92.23	3.00
90H46	UR86B19-10 (84B7-8)	5437	225.3	24.17	16.32	92.24	2.83
90H47	UR86B19-16 (84B7-34)	5491	210.7	26.05	15.47	91.83	2.67
90H50	88H11-12 (85700 H/S)	5405	205.4	26.30	15.11	91.86	1.83
90H52	88H11-16 (85700 H/S)	5072	208.5	24.34	15.14	92.39	1.83
90H57	88H13-3 (85700 H/S)	5336	209.2	25.53	15.23	92.26	2.17
90H58	88H13-4 (85700 H/S)	5379	212.1	25.37	15.38	92.41	1.83
90H59	88H13-5 (85700 H/S)	5916	200.8	29.50	14.76	91.93	2.00
90H65	88H8-6 (8549-27 H/S)	5658	207.8	27.27	15.04	92.57	1.50
90H69	88H17-1 (85115-3 H/S	5490	209.4	26.20	14.82	93.67	2.17
90H70	88H26-2 (85131-16H/S	5671	194.9	29.05	14.60	91.23	1.83
90H74	88H49-5 (8549-18 H/S	4646	202.7	22.92	14.80	92.23	1.83
90H75	88H49-8 (8549-18 H/S	5314	203.8	26.01	14.86	92.31	2.17
90H76	88H56-1 (8549-38 H/S	5798	202.1	28.71	14.82	92.06	1.50
90H78	88H56-3 (8549-38 H/S	5635	208.7	26.95	15.26	92.06	2.00
90H79	88H56-10 (8549-38H/S	5055	209.3	24.19	15.13	92.58	1.67
90H80	88H60-1 (8549-51 H/S	5574	218.6	25.51	15.32	93.99	1.67
Mean		5443	210.7	25.92	15.32	92.27	2.35
lsd (0.05)		731	13.4	3.34	0.59	1.51	0.55
CV		8.25	3.89	7.91	2.35	1.01	14.53

EVALUATION OF SMOOTH ROOT AND OTHER EXPERIMENTAL HYBRIDS IN 22" VERSUS 28" ROW SPACINGS

J. C. Theurer

Eight varieties were seeded in a field test to compare agronomic performance of experimental hybrids under 2 plant population densities. The entries included MHI E4 and ACH 185 commercial hybrids, two SR87, two SR80, one 84B9-24-00, and one 85300-115 experimental hybrids. The entries were planted May 31, 1991 in a randomized design of 4 replications with the restriction of having the row widths in strips across the field so that all plots could be machine harvested. Two row widths, 22" and 28", with plants spaced 8-10 inches apart within the row were used to give plant densities of approximately 28,000 and 22,000 plants, respectively. The plots were planted between the wheel tracks of a tractor with wheels spaced 84" apart. Individual plots consisted of 3 rows for the 28" and 4 rows for the 22" row widths. Plot length was 25 feet. At harvest on October 17, all beets from the center row of each plot of the 28" spacing and the center 2 rows of the 22" spacing were machine harvested and weighed. The weights for the two plant densities were adjusted for the size of the harvested plot area in calculating the tons per acre yield of roots. A bag of 15 to 20 beets was randomly selected from each plot for laboratory analyses of sucrose percentage and clear juice purity. Beets from each plot were observed as they fell off the grab rolls of the harvester into the weighing bucket and a root smoothness score from 1= very smooth to 5= grooved and rough shaped roots, was given for each plot. The analyses of sugar and purity were performed by Michigan Sugar Company personnel in their research laboratory at Carrollton, MI.

Results

Yield, sucrose percentage, purity, and smooth root scores are listed in Table 3. There were no significant differences between the two plant densities for any of the variables measured. Also, there was no interaction among the varieties under the 2 plant densities. These results differ from previous years studies which had shown a tendency for the narrower row planting to be slightly higher in root yield. This test was planted quite late due to the unavailability of a needed drill. It may be that the shortness of the growing season was responsible for the lack of differences between the 2 plant densities. There was a significant difference between the hybrids for each variable except for the CJP percentage. ACH 185 was better than most experimental varieties for RWSA and RWST and sugar percentage. Of the experimental hybrids, SR80 and 85300-115 had higher RWST and sucrose percentage, while SR87 and the 84B9-24 hybrids had the greater root yield and RWSA. Sucrose percentage for SR 80 was 0.9% lower than MHI E4, and 1.3% lower than ACH 185. SR87 had 1.1% lower sucrose than MHI E4 and 2.4% less than ACH 185. SR87 and SR80 with the exception of the 576CMS x SR80 hybrid were significantly lower than the commercial varieties, in smooth root score.

Table 3. RWSA, RWST, sucrose percentage, clear juice purity, and root smoothness score for standard and smooth root experimental hybrids grown in two plant densities. B&B Farm, Swan Creek, MI. 1991.

Variety Description	RWSA 22"	RWSA 28"	RWST 22"	RWST 28"	T/A 22"	T/A 28"
MHI E4	5221	4946	254.3	252.1	20.51	19.55
ACH185	6246	5512	276.5	272.0	22.59	20.27
H23CMS x SR80	4594	5197	243.0	247.9	18.97	20.99
H23CMS x SR87	5199	5171	238.0	229.1	21.83	22.55
576CMS x SR80	4599	4773	248.0	245.7	18.55	19.45
576CMS x SR87	5264	5428	240.4	239.3	21.88	22.73
(6926xEL48)x 84B9-24	4701	4241	246.9	245.3	19.02	17.33
EL36xEL45)x85300-115	5237	5628	243.1	242.2	21.68	23.25
Overall Mean	5122		247.7		20.70	
lsd (0.05) Row Spacing	NS		NS		NS	
lsd (0.05) Variety	675		9.9		2.68	
lsd (0.05) Var. x Row Sp.	NS		NS		NS	
CV	13.10		3.97		12.89	

	Sucr% 22"	Sucr% 28"	CJP % 22"	CJP % 28"	Root Sm Score 22"	Root Sm Score 28"
MHI E4	17.80	17.53	93.46	93.79	3.25	3.25
ACH185	19.03	18.89	93.99	93.61	2.88	3.13
H23CMS x SR80	16.94	17.13	93.77	94.15	2.50	2.63
H23CMS x SR87	16.67	16.21	93.64	93.28	2.13	2.25
576CMS x SR80	17.17	16.94	94.07	94.38	3.00	3.00
576CMS x SR87	16.68	16.62	94.05	94.08	2.25	2.75
(6926xEL48)x 84B9-24	16.92	17.09	94.70	93.80	3.13	3.25
EL36xE145)x85300-115	17.09	16.92	93.38	93.69	3.13	3.13
Overall Mean	17.23		93.86		2.85	
lsd (0.05) Row Spacing	NS		NS		NS	
lsd (0.05) Variety	0.35		NS		0.35	
lsd (0.05) Var. x Row Sp.	NS		NS		NS	
CV	2.06		1.48		12.04	

COMPARATIVE AGRONOMIC PERFORMANCE OF SOIL FREE AND SMOOTH ROOT TYPES WITH STANDARD ROOT TYPE COMMERCIAL CULTIVARS

J. C. Theurer

An experiment was planted May 14, 1991, in sandy loam soil at the Botany Research Farm in East Lansing, to compare the agronomic performance of soil-free and smooth root varieties with commercial hybrids. This field trial was similar to a 1990 experiment conducted at the B & B Farm near Saginaw, MI. However, the 1990 experiment was on land of heavy clay soil and did not provide opportunity to distinguish variety performance for the quantity of soil that was harvested with roots.

There were 6 entries in the field trial: 3 commercial hybrids, MHI E4, ACH 185, and ACH 176; Univers, a soil-free European commercial hybrid developed by Van der Have Seed Company in the Netherlands; a globe shaped beet, A90-MM, developed by Dr. M. Meskin at the Wageningen, Netherlands, breeding station; and the smooth root line, SR87, developed at East Lansing. The experiment was a randomized block of 4 replications. Individual field plots consisted of two 28" rows 30 feet in length, with beets spaced 8"-12" within the row. The plots were harvested October 22, 1991, using a single row miniharvester. All beets were placed in bags with care to avoid knocking off soil that was adhering to each root. Beets were subsequently cleaned, and a weight was taken of all the roots harvested in each plot and also the weight of the soil removed from the roots. A sample of soil from each plot was dried in an 85^{o} F oven to determine the dry weight of the soil harvested with the beet roots. A 12-beet sample from each plot was processed and evaluated at the Michigan Sugar Company Research Laboratory at Carrollton, MI., for sucrose percentage and clear juice purity.

Results

The long growing season and the relatively high fertility under which the beets were grown resulted in extremely large beets, both for tops and roots. Significant differences were observed between the 6 entries for all variables except CJP percentage (Table 4). The commercial hybrid ACH 185 had the highest RWSA, RWST, and sucrose percentage. SR87 significantly outyielded all other entries in tons per acre root yield. ACH176 and MHI E4 also were significantly higher than the smooth root types for RWST and sucrose percentage. The quantity of soil harvested with the commercial cultivars was 2- to 4-fold of that harvested with the smooth root type beets. The globe shaped root variety, A90MM, had only 67 pounds of soil harvested per ton of beets. Roots of this variety are shaped like a huge table beet and they grow well out of the ground. This no doubt accounted for the low quantity of soil adhering to the beet surface. Results of

this experiment were different from those observed last year. In particular, Univers had the highest RWSA, and Univers and 90 MM were highest in tonnage. SR87 was better than 90 MM globe beet for sucrose percentage and clear juice purity in 1990, but not in 1991 field tests.

Table 4. Sugar yield, root yield, sucrose percentage, CJP percentage and pounds of soil harvested with the taproots. Botany Farm, East Lansing, 1991.

Variety		RWSA	RWST	T/A
MHE4	Commercial Hybrid	7561 b	217 b	34.89 b
ACH185	High Sugar Hybrid	8624 a	251 a	34.42 b
ACH176	High Sugar Hybrid	7938 ab	226 b	35.13 b
UNIVERS	Low soil tare hybrid	6327 c	191 c	33.06 b
A90-MM5	Globe Shape Triploid	6549 c	183 c	36.04 b
WC87021	SR87 Smooth Root	7672 b	180 c	42.57 a
Mean		7444	208	36.02
lsd (0.05)		704	20	4.04
CV		6.28	6.30	7.44

Variety		Sucr%	CJP%	Soil lb/T
MHE4	Commercial Hybrid	16.68 b	90.28 a	287.5 a
ACH185	High Sugar Hybrid	17.89 a	91.55 a	268.2ab
ACH176	High Sugar Hybrid	16.42 b	92.08 a	246.7 b
UNIVERS	Low soil tare hybrid	14.58 c	90.90 a	140.5 c
A90-MM5	Globe shape triploid	13.88 c	92.03 a	67.0 d
WC87021	SR87 Smooth Root	13.87 c	90.31 a	105.7 c
Mean		15.55	91.11	185.9
lsd (0.05)		0.73	NS	38.6
CV		3.10	2.74	13.79
44.2				

1991 EXPERIMENTS OF GENOTYPE X NITROGEN RESPONSE

J. C. Theurer and J. W. Saunders

Two field experiments were conducted in 1991 to observe variation for nitrogen use response. These 2 experiments were a repeat of 1990 field trials. Experiment 913 was set up to evaluate the nitrogen use response of high sugar breeding lines. Experiment 914 was an evaluation of the nitrogen use response for high sugar type commercial and experimental varieties developed with high sucrose germplasm from diverse sources.

<u>Experiment 913 - High Sugar Breeding Line Evaluation For Nitrogen Use Response</u>. Seven diverse high sugar lines and 3 commercial varieties, MHI E4, ACH 185, and ACH 176, were planted in a 3-replication randomized block experiment on May 15, 1991. Individual plots were 2 rows 28" apart and 30 feet in length. Prior to planting, composite soil samples at 1′, 2′, and 3′ depths were taken to the soils laboratory at Michigan State University and analyzed for plant nutrients. Phosphorus and potassium fertilizer as recommended by soil test was applied to the soil preplant, but no nitrogen fertilizer was applied. After thinning, on July 15, four fertilizer treatments (N_0=0, N_1=60, N_2=120, and N_3=180 pounds available N per acre) were applied to the experiment by hand side dressing of urea along one side of each plant row. Each nitrogen treatment was applied across a block within each replication. Four buffer rows of MHI E4 were used to border the fertilizer trials from other adjacent experiments. The experiment was harvested by machine on October 9, and a 15-beet sample from each plot was taken for laboratory analyses of sucrose percent, clear juice purity, and residual amino nitrogen in the root.

<u>Results</u>

Plants in the N_0 treatment showed yellowing of leaves in August, and at harvest the canopy did not completely cover the soil surface between rows. The 3 other treatments also showed lighter green color of the foliage than observed in the 1990 field fertility trial with the same entries. This was probably a reflection of inadequate N in the early spring and the late date of application of the differential fertilizer treatments.

The analyses of variance indicated that there were significant differences between N levels and between varieties for all of the variables measured (Table 1-1). The root yield (tons/acre) and sugar yield per acre (RWSA) was low for N_0 compared to the other fertilizer treatments. However, there was no increase in yield above the N_1 level. Sucrose percentage, RWST, and purity decreased and the quantity of amino N in the root at harvest increased as nitrogen increments were increased. The 3 commercial hybrids had the highest RWSA and tons per acre as

would be expected. The 550 high sugar line was by far the lowest yielding variety. The L19 selected line had significantly the highest sucrose percentage and RWST. Lines 550, C51, and 4n Polish ranked second for high sucrose percentage and RWST, while A3952 was lowest. C40, A3952, and F1010 had significantly low CJP percentage values. Lines 550, C51 and L19 were significantly higher than the other entries in ppm amino N, while 4n Polish and the commercial hybrids were lowest among the entries for this variable.

Nitrogen x variety interactions were highly significant for tons per acre, sugar percentage, CJP percentage and amino N (Table 1-2). In general, tons per acre yield increased as nitrogen increments increased. However, for 4 of the entries (ACH 185, C51, L19, and 550), significant differences in yield were not observed among the N treatments. Four of the entries (ACH 176, A3952, F1010, and C40) showed a significant difference between N_0 and the other N treatments for root yield. MHI E4 had significantly the highest root yield at N_3. The N_0 treatment had significantly higher sucrose for L19, F1010, MHI E4, and ACH 185 than at higher N levels. Three entries, 4n Polish, A3952, and C51 gave equal sucrose percentage for the N_0 and N_1 levels, but showed a reduction in sucrose percentage at higher N Levels. C40 showed no significant reduction in sugar percentage up to N_2.

Although there was a general trend for CJP percentages to decrease as N levels increased, differences were nonsignificant across N levels for ACH 185, L19, F1010, or 550. The 4n Polish line had significantly higher CJP percentage at N_0 level, but the purity was similar for the other N levels. The other entries, C40, C51, and A3925, showed significantly lower purity when N level reached 180# per acre.

Three different groupings were observed for the interaction of varieties and N levels for m.e.q. amino N/100 grams sugar. ACH 185, L19, C51, and 550 at N_3 were significantly higher in amino N than at N_2 or other lower N Levels. The second group consisting of MHI E4, ACH 176, and 4n Polish showed a step wise pattern of significant differences, wherein N_3 was equal to N_2 but higher than N_1, and N_2 was equal with N_1 but higher than N_0. In the third group (C40, A3952 and F1010), N_2 and N_3 were equal and significantly higher than N_0 or N_1.

Experiment 914 - Evaluation of High Sugar Hybrid Varieties for Nitrogen Use Response. Eleven high sugar commercial and experimental hybrids were planted May 15, 1991, in 3 replications of a randomized block field test. Prior to planting, a soil sample was taken and analyzed for nutrients as cited above for Experiment 913. Experiment 914 was grown on land adjacent to Experiment 903 and subsequently fertilized in the same manner and at the same rates as cited above. Harvest

was made on October 17, and a 15-beet sample was taken for laboratory analyses similar to experiment 913 listed above.

Results

Significant differences were noted between varieties summed across N levels, and for nitrogen levels summed across varieties for root yield, sugar yield, sucrose percentage, clear juice purity, and ppm amino N in the roots at harvest (Table 2-1). The N_0 level produced lower RWSA than the other N levels. Sucrose percentage and RWST decreased and amino N increased with each added increment of N fertilizer. Tons per acre significantly increased and CJP percentage decreased from N_0 to N_1 and from N_1 to N_2. KW2398 and HMI 5135 had the highest and KW1119, and MHI E4 had the lowest RWSA. ACH87-353 and Beta 5315 were best for sucrose percentage and RWST, while WC87212, MHI E4 and Monohikari had the lowest values for these 2 variables. The experimental hybrid WC87212 produced significantly the greatest root yield followed by HMI 5135. ACH 85-323 and KW1119 had the lowest tons per acre. Monohikari was highest in CJP percentage. ACH 85-153, Monohikari and ACH 87-353 were the varieties with the lowest amino N in the root at harvest.

The varieties had similar responses with increased levels of nitrogen for sucrose percentage, RWST, CJP percentage, and amino N (Table 2-2). However, there were significant variety x nitrogen interactions for tons per acre and RWSA. Monohikari and KW2398 showed no increase in RWST with increases in N. WC87212 and ACH 85-323 were only significantly different in RWSA between the zero and higher N levels. ACH 185 had significantly higher RWST at the 120# N rate, and ACH 85-153 at the 60# N rate than at other N levels. While most varieties showed increased tons per acre root yield with increasing increments of N, Beta 5315 showed no difference among the 4 fertility levels. ACH 185 gave significantly the highest root yield at the 160# N rate, and ACH 85-153 was highest at the 60# rate.

Table 1-1. Means by nitrogen level and variety for sugar yield, root yield, sucrose percentage, clear juice purity percentage, and meq/l amino N. B&B Farm. 1991.

N Level		RWSA	RWST	T/A	Sucr%	CJP%	Amino N meq/l
0	Nitrogen	3984	276.0	14.70	18.83	94.43	9.60
60	Nitrogen	4492	257.2	17.52	18.01	93.40	11.57
120	Nitrogen	4357	242.7	18.09	17.15	93.14	15.41
180	Nitrogen	4350	236.7	18.56	17.09	92.24	17.83
Mean		4296	253.2	17.22	17.77	93.30	13.60
lsd (0.05)		253	5.6	1.08	0.24	0.62	1.91

Variety Description	RWSA	RWST	T/A	Sucr%	CJP%	Amino N meq/l
MHE4	4992	243.8	20.62	16.97	93.84	12.18
ACH 185	5148	258.3	20.05	17.99	93.60	12.16
ACH 176	5542	252.7	22.14	17.59	93.70	12.10
C40 High Sugar	3973	243.5	16.38	17.61	92.07	12.78
C51 High Sugar	3774	256.9	14.78	18.03	93.23	16.41
A3952 High Sugar	4489	225.7	20.04	16.34	92.23	15.95
L19 Sel. High Sugar	3952	278.4	14.25	19.33	93.53	14.78
F1010 High Sugar	4364	249.7	17.65	17.66	93.01	12.54
EL550 High Sugar	1812	260.4	7.37	18.18	93.50	17.08
4N Polish High Sugar	4909	262.3	18.88	17.98	94.34	10.06
Mean	4296	253.2	17.22	17.77	93.30	13.60
lsd (0.05)	400	8.9	1.72	0.38	0.98	1.56

Table 1-2. RWSA, RWST, sucrose percentage, CJP percentage, and meq/l amino nitrogen for high sugar lines and 3 commercial varieties at 4 applied nitrogen levels. B&B Farm, Swan Creek, MI. 1991.

Variety Description	RWSA	RWST	T/A	SURC%	CJP %	Amino N meq	Level N
MHE4	5172	262.7	19.69	17.94	94.57	7.52	0
	5039	253.1	19.99	17.30	94.63	10.64	60
	4477	237.8	18.85	16.64	93.69	13.97	120
	5281	221.7	23.96	15.99	92.46	16.61	180
ACH 185	4873	278.6	17.54	19.05	94.30	10.58	0
	5476	267.0	20.60	18.48	93.82	9.09	60
	5309	251.8	21.13	17.62	93.48	11.74	120
	4934	235.7	20.92	16.82	92.79	17.23	180
ACH 176	4533	275.9	16.46	18.78	94.54	8.30	0
	6441	259.8	24.89	17.85	94.29	10.41	60
	5519	242.8	22.76	17.03	93.50	13.92	120
	5674	232.2	24.44	16.70	92.46	15.77	180
C40 High Sugar	3763	262.8	14.30	18.29	93.61	8.68	0
	3688	245.5	15.03	17.64	92.34	11.08	60
	4504	244.2	18.38	17.60	92.27	16.22	120
	3937	221.4	17.81	16.90	90.05	15.13	180
C51 High Sugar	3672	285.1	12.93	19.41	94.44	12.48	0
	3947	264.9	14.90	18.34	93.85	14.16	60
	3671	233.1	15.68	16.76	92.48	17.43	120
	3805	244.3	15.62	17.62	92.15	21.59	180
A3952 High Sugar	4430	256.9	17.28	17.70	94.19	9.92	0
	4933	235.4	21.01	16.80	92.78	14.58	60
	4510	201.1	22.38	15.05	91.22	15.76	120
	4084	209.6	19.51	15.79	90.74	14.44	180
L19 Sel. High Sugar	3520	293.9	11.97	19.99	94.42	10.58	0
	4187	285.9	14.64	19.86	93.44	14.22	60
	3960	268.2	14.79	18.64	93.61	15.14	120
	4143	265.5	15.61	18.85	92.65	19.17	180
F1010 High Sugar	3480	269.1	12.94	18.53	94.07	9.35	0
	4612	247.3	18.80	17.88	92.09	10.62	60
	4701	238.8	19.70	16.96	92.98	15.76	120
	4663	243.5	19.16	17.29	92.91	14.44	180
EL550 High Sugar	2138	286.8	9.23	19.66	94.07	12.57	0
	1629	247.8	6.55	17.71	92.53	12.15	60
	1944	255.8	7.58	17.55	94.46	19.54	120
	1537	251.0	6.14	17.80	92.94	24.07	180
4N Polish High Sugar	4253	288.0	14.69	18.97	96.13	6.07	0
	4967	265.3	18.76	18.24	94.19	8.79	60
	4975	253.4	19.63	17.62	93.76	11.76	120
	5441	242.3	22.43	17.08	93.27	13.60	180
Mean	4296	253.2	17.22	17.77	93.30	13.60	
lsd (0.05) Var. x N	799	17.8	3.43	0.76	1.96	3.11	
CV	11.45	4.33	12.26	2.62	1.29	15.93	

Table 2-1. Means by nitrogen level and variety for sugar yield, root yield, sucrose percentage, clear juice purity percentage, and meq/l amino N. B&B Farm, 1991.

N Level		RWSA	RWST	T/A	Sucr%	CJP %	Amino N meq/l
0	Nitrogen	5364	276.6	19.55	18.93	94.34	9.4
60	Nitrogen	5847	266.8	21.99	18.32	94.23	13.9
120	Nitrogen	5813	248.3	23.49	17.54	93.06	12.1
180	Nitrogen	5711	241.3	23.78	17.23	92.66	14.1
Mean		5684	258.2	22.20	18.00	93.58	12.4
lsd (0.05)		219	4.3	0.81	0.21	0.38	2.2

Variety		RWSA	RWST	T/A	Sucr%	CJP %	Amino N meq/l
1	MHE4	5407	248.6	21.87	17.35	93.82	12.9
2	Monohikari	5513	251.9	21.95	17.39	94.15	13.1
3	KW 1119	5326	261.0	20.53	18.23	93.44	11.5
4	KW 2398	5942	259.3	22.97	18.07	93.60	13.7
5	ACH 185	5769	265.7	21.83	18.57	93.36	15.0
6	ACH 85-153	5826	267.1	21.81	18.39	94.06	14.1
7	ACH 87-353	5519	273.6	20.27	18.84	94.01	12.9
8	ACH 85-323	5711	266.2	21.72	18.61	93.33	11.1
9	Beta 5315	5815	273.6	21.36	18.84	93.99	10.1
10	HMI 5135	5933	253.0	23.63	17.82	93.12	10.1
11	WC87212	5763	220.7	26.29	15.93	92.44	11.4
Mean		5684	258.2	22.20	18.00	93.58	12.4
lsd (0.05)		364	7.1	1.35	0.34	0.63	1.8

Table 2-2. RWSA, RWST, sucrose percentage, CJP percentage, and meq/l amino N for commercial and experimental high sugar varieties at four applied nitrogen levels. B&B Farm, Swan Creek, MI. 1991.

Variety	RWSA	RWST	T/A	Sucr%	CJP%	Amino N meq/l	N Level
MHE4	5192	259.9	20.00	17.94	94.82	7.5	0
	5427	267.3	20.29	18.13	94.85	15.9	60
	5280	235.5	22.44	16.78	92.85	12.6	120
	5728	231.4	24.75	16.55	92.74	15.6	180
Monohikari	5524	268.6	20.56	18.04	95.34	7.2	0
	5547	259.7	21.35	17.74	94.57	16.2	60
	5664	235.8	24.02	16.72	93.07	10.9	120
	5318	243.4	21.85	17.04	93.60	18.1	180
KW 1119	4819	282.6	17.08	19.41	94.02	6.1	0
	5512	264.7	20.85	18.26	94.03	15.4	60
	5246	250.8	20.92	17.72	93.04	9.2	120
	5727	245.8	23.26	17.52	92.68	15.4	180
KW 2398	5955	280.5	21.24	19.02	94.72	8.1	0
	5772	264.8	21.79	18.03	94.68	18.2	60
	5905	245.0	24.03	17.40	92.86	11.8	120
	6135	247.0	24.84	17.84	92.13	16.9	180
ACH 185	4987	282.0	17.76	19.37	94.03	9.4	0
	5828	270.4	21.58	18.90	93.32	15.5	60
	6726	262.2	25.65	18.32	93.44	16.5	120
	5536	248.2	22.32	17.69	92.66	18.5	180
ACH 85-153	5634	288.9	19.52	19.47	94.94	8.8	0
	6721	274.3	24.54	18.74	94.39	16.4	60
	6033	265.7	22.69	18.29	94.11	13.8	120
	4916	239.5	20.48	17.07	92.80	17.5	180
ACH 87-353	4928	289.5	17.10	19.73	94.33	8.9	0
	5539	277.2	19.97	18.89	94.50	15.6	60
	5768	266.1	21.66	18.43	93.80	13.4	120
	5842	261.6	22.33	18.29	93.42	13.8	180
ACH 85-323	5179	287.0	18.50	19.75	93.89	12.3	0
	5993	274.5	21.93	18.80	94.26	11.5	60
	5754	257.1	22.39	18.24	92.78	10.8	120
	5917	246.3	24.04	17.67	92.40	9.8	180
Beta 5315	6304	295.0	21.71	19.98	94.61	12.5	0
	5675	285.4	19.89	19.35	94.66	9.9	60
	5729	259.8	22.06	18.25	93.20	10.6	120
	5550	254.1	21.79	17.77	93.49	7.7	180
HMI 5135	5456	276.6	19.81	19.02	94.00	9.2	0
	6378	261.2	24.45	18.12	93.81	8.3	60
	5777	241.4	23.95	17.19	92.80	11.8	120
	6121	232.7	26.30	16.95	91.88	11.1	180
WC87212	5030	231.5	21.77	16.45	93.05	13.6	0
	5931	235.3	25.24	16.53	93.52	9.7	60
	6057	212.2	28.55	15.61	91.73	11.8	120
	6034	204.0	29.61	15.14	91.47	10.4	180
Mean	5684	258.2	22.20	18.00	93.58	12.4	
lsd (0.05) Var. x N	727	14.1	2.70	0.68	1.25	3.6	
CV	7.88	3.37	7.50	2.34	0.82	18.05	

SELECTION IN DIVERSE BREEDING POPULATIONS FOR NITROGEN USE EFFICIENCY

J. C. Theurer

A series of 13 sugarbeet breeding lines of wide diversity were planted under low (no nitrogen fertilization) and high (180 pounds available N per acre) for yield and sucrose evaluation. The purpose of the experiment was to see if there were differences in the way the genotypes responded to nitrogen, and to make selections for N use efficiency. The goal under the low N treatment was to select beets that demonstrated their N use efficiency by producing good yield and high sugar content in the absence of what might be termed optimal fertilization (usually 90-100 pounds N per acre). Selection in the high nitrogen treatment was aimed at isolating genotypes that had the ability to metabolize high N levels to an advantage giving rise to larger yields without appreciable loss of sucrose content nor substantial rise in nitrogenous impurities in the sugarbeet root at harvest. Individual plots consisted of two 28" rows 30 feet in length. There were 2 replications for each N treatment. The high nitrogen treatment was made by side dressing each row of beets with 180 pound per acre rate of urea fertilizer on July 30, 1991.

The experiment was machine harvested on October 17, 1991. Individual beets with good root size and shape, and single crowns were also selected from each line for use in the breeding program. A 15-beet sample was taken from each plot for laboratory analysis of sucrose percentage, clear juice purity and amino N content. One-half root of each individual beet was sawed into brei and used for laboratory analysis while the other half was stored in a cold room at 40^{o} C for use in breeding. Any individual beet determined to have sucrose percentage lower or amino N higher than the mean of the plot sample for these 2 variables was discarded. The other half-roots will be used for seed increase and recurrent selection for N use efficiency. Since there were only 2 replications and 2 fertilizer treatments, significance between means and variances were estimated using the statistical "t" test.

Results

Significant differences were noted between varieties and between the two nitrogen levels for all of the variables measured, with 2 exceptions. These 2 were the RWSA N treatments and m.e.q. amino N /100 grams sugar for the varieties (Table 3). All of the nitrogen x variety interactions across all of the variables were non-significant. However, differences in tons per acre approached the 0.05 level. The general trend of higher yield, lower sucrose percentage, and higher amino N with increased nitrogen was observed. Varieties 89B9-15 and 88B23-00 had the highest sucrose percentage of the 13 varieties at both N levels. Varieties 89B2-13-2, 89B12-1, and 88B23-00 showed the

greatest negative effect among the varieties for sucrose percentage at low versus high N level. These varieties showed in excess of 1% decrease under the high N treatment. M101 showed the least change in sucrose percentage with a reduction of only 0.04%. The amino N content of the root for the N^0 versus N^{180} treatment showed an average increase of 8.49 m.e.q./ 100 grams sugar. Varieties 88B24-00 and 88B2-00 showed the least change and 84289-34 had the greatest change in amino N due to increased N fertilization. Varieties 88B19-00 and 88B21-00 had the lowest amino N content under the zero fertilization, while 8B24-00 was lowest in m.e.q./ 100 grams under the high N treatment. Variety 88B2-00 had the highest amino N under the N^0 treatment and 89B12-1 had the highest amino N content under the N^{180} treatment.

Table 3. RWSA, RWST, Sucrose percentage, CJP percentage and Amino N Content for diverse genotypes, under two nitrogen treatments, B & B Farm, Swan Creek, MI 1991

Variety			RWSA			RWST			T/AC		
			N^0	N^{180}	MEAN	N^0	N^{180}	MEAN	N^0	N^{180}	MEAN
88B24-00	86B1-00		5861.	4664.	5262.	223.9	211.2	217.5	26.28	22.08	24.18
88B19-00	85B2R26	4501.	5346.	4924.	255.3	224.3	239.8	17.59	23.80	20.69	
88B20-00	84B9-24	3910.	4837.	4374.	239.7	218.3	229.0	16.32	22.20	19.26	
88B21-00	84B9-71	4519.	5092.	4806.	230.4	225.6	228.0	19.66	22.53	21.09	
89H18	M101 CANADA	4920.	4748.	4834.	238.1	232.3	235.2	20.67	20.46	20.56	
89B9-15	FC8II059H	4758.	5516.	5137.	255.8	266.4	241.1	18.57	24.41	21.49	
89B2-15	84S4-00	5091.	5849.	5470.	242.6	227.8	235.2	20.96	25.69	23.33	
89B2-13-2	FC912	3735.	3173.	3454.	226.0	175.0	200.5	16.59	18.15	17.37	
89B12-1	84298-34	5402.	4606.	5004.	226.0	196.7	211.3	23.95	23.53	23.74	
88B2-00	85B2-R14	4643.	4493.	4568.	204.7	195.0	199.9	22.84	23.07	22.95	
88B17-00	84B9-66	5128.	5211.	5169.	228.5	215.1	221.8	22.50	24.21	23.35	
88B23-00	WC86403	4833.	5367.	5100.	249.6	225.5	237.5	19.40	23.76	21.58	
89H92	SR87 SELECT		3827.	4990.	4409.	210.2	222.2	216.2	18.12	22.51	20.31
	MEAN		4702.	4914.	4808.	223.1	215.0	224.1	20.27	22.80	21.53
N "t" test 0.05			NS			10.73			1.65		
Variety LSD 0.05					1101			18.5			3.10
N X Variety LSD 0.05				NS			NS			NS	
CV				11.11			5.68			9.88	

Table 3. Continued

Variety		Sucrose %			CJP %			m.e.q. Amino N/100gm Sugar		
		N^0	N^{180}	MEAN	N^0	N^{180}	MEAN	N^0	N^{180}	MEAN
88B24-00	86B1-00	15.97	15.36	15.66	92.93	92.30	92.61	10.4	14.2	12.3
88B19-00	85B2R26	17.16	15.99	16.58	95.50	92.97	94.24	7.1	17.1	12.1
88B20-00	84B9-24	16.71	15.75	16.23	93.86	92.53	93.20	8.8	19.1	14.0
88B21-00	84B9-71	16.92	16.19	16.56	91.59	92.66	92.13	7.5	19.0	13.2
89H18	M101 CANADA	16.64	16.60	16.62	93.75	92.77	93.26	10.2	17.2	13.7
89B9-15	FC8II059H	17.57	16.31	16.94	94.35	92.47	93.41	8.3	19.2	13.7
89B2-15	84S4-00	17.03	16.09	16.56	93.46	93.39	93.42	10.7	16.7	13.7
89B2-13-2	FC912	16.04	13.78	14.91	93.16	89.50	91.33	14.2	18.3	16.3
89B12-1	84298-34	16.25	15.07	15.66	92.54	90.22	91.38	11.9	28.2	20.0
88B2-00	85B2-R14	14.97	14.80	14.88	92.12	90.67	91.39	16.9	21.0	18.9
88B17-00	84B9-66	16.06	15.49	15.77	93.60	92.67	93.14	11.7	19.4	15.5
88B23-00	WC86403	17.43	16.21	16.82	93.61	92.57	93.09	9.9	20.4	15.2
89H92	SR87 SELECT	16.75	15.90	16.33	94.12	92.84	93.48	7.5	15.6	11.6
	MEAN	16.58	15.66	16.12	93.43	92.12	92.78			
N "t" test 0.05		0.45			0.79			5.25		
Variety LSD 0.05				0.59			1.73			NS
N X Variety LSD 0.05			NS			NS			NS	
CV			2.51			1.28			28.05	

MOLECULAR STUDIES OF DIVERSE CMS LINES

J. C. Theurer and Carrie Heiser

Five potentially different CMS sources (Table 1) were studied by molecular techniques in 1991 to ascertain whether they had similar or different endonuclease restriction patterns. They were compared with lines C1 and C1 CMS which we have used as standards for the Owen "S" source of male-sterile cytoplasm, which is being used internationally today in the development of hybrid sugarbeet seed. Mitochondrial DNA was extracted from tap roots of sugarbeets for each source of cytoplasm. The MtDNA was cut with ECO R1 and BAM H1 restriction enzymes and then hybridized with 4 maize probes (Atp-6, Atp-9, COX I, and COX II) thought to be associated with cytoplasmic male sterility. Results are summarized in Table 2. C23 and C24 had similar restriction patterns and were different from C1 and C1 CMS. There was a prominent band found in C23 and C24 that was not observed when the MtDNA was cut with ECO R1 and probed with COX II (Figure 1) and Atp-9 (Figure 3). C7 and C9 showed a unique band when cut with Bam H1 and probed with COX II (Figure 2). C5 lacked a band which was common to all other sources when cut with ECO R1 and probed with Atp-9 (Figure 3).

Table 1. Source of male sterile cytoplasm.

Plasm Source No.	Description
C1	Normal cytoplasm O-type maintainer (NB-1)
C1 CMS	Owens "S" type CMS
C5 CMS	Powers red anther CMS
C7 CMS	CMS from a KWS source
C9 CMS	CMS found in NC 7 Collection of Beta
C23 CMS	CMS found in NC 7 Collection of Beta
C24 CMS	CMS found in NC 7 Collection of Beta

Table 2. Summary comparison of RFLP's of diverse sources of sterile cytoplasm

Source of CMS	Restriction Enzyme: ECO R1	Restriction Enzyme: BAM H1
Probe: COX I		
C5	Similar to C1	Similar to C1
C5 & C9	Partially cut - appears different than C1	Similar to C1
C23 & 24	Different than C1	Similar to C1
Probe: COX II		
C5	Didn't cut - no conclusions could be made	Only partially cut but is similar to C1
C7	Only partially cut-appears to be similar to C23 & C24	Only partially cut but was not similar to other lines - has 1 unique band
C9	"	"
C23 & C24	Distinctly different than C1 and C1 CMS - has a unique band not found in C1 or C1 CMS	Distinctly different than than C1 and C1 CMS
Probe: Atp-6		
C5, C7, C9	Are similar and not like C1 or C1 CMS	Staining too faint for conclusions except C7 is similar to C9
C23 & C24	Are similar but not like C1 or C1 CMS	Staining too faint for any conclusions
Probe: Atp-9		
C5	Different from other lines. Marked absence of 1 band occurring in other CMS	Similar to C1 normal
C7	Partially cut - may be like C1	Partially cut - probably similar to C1
C9	Appears similar to C23 & C24 or may be unique	Similar to C23 & C24 and different from C1
C23 & C24	Are alike and different from C1	Are alike and different from C1

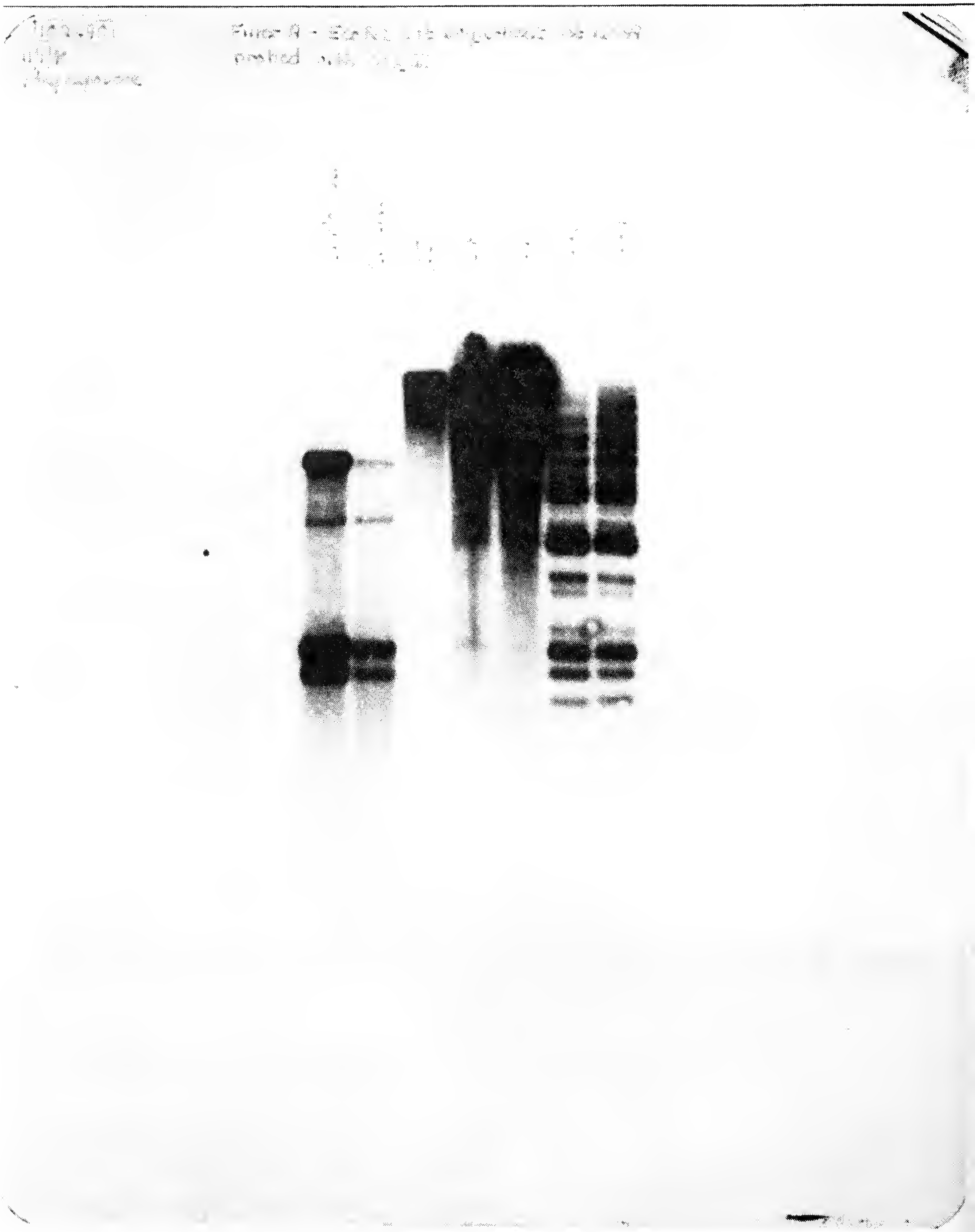

FIGURE 1

FIGURE 2

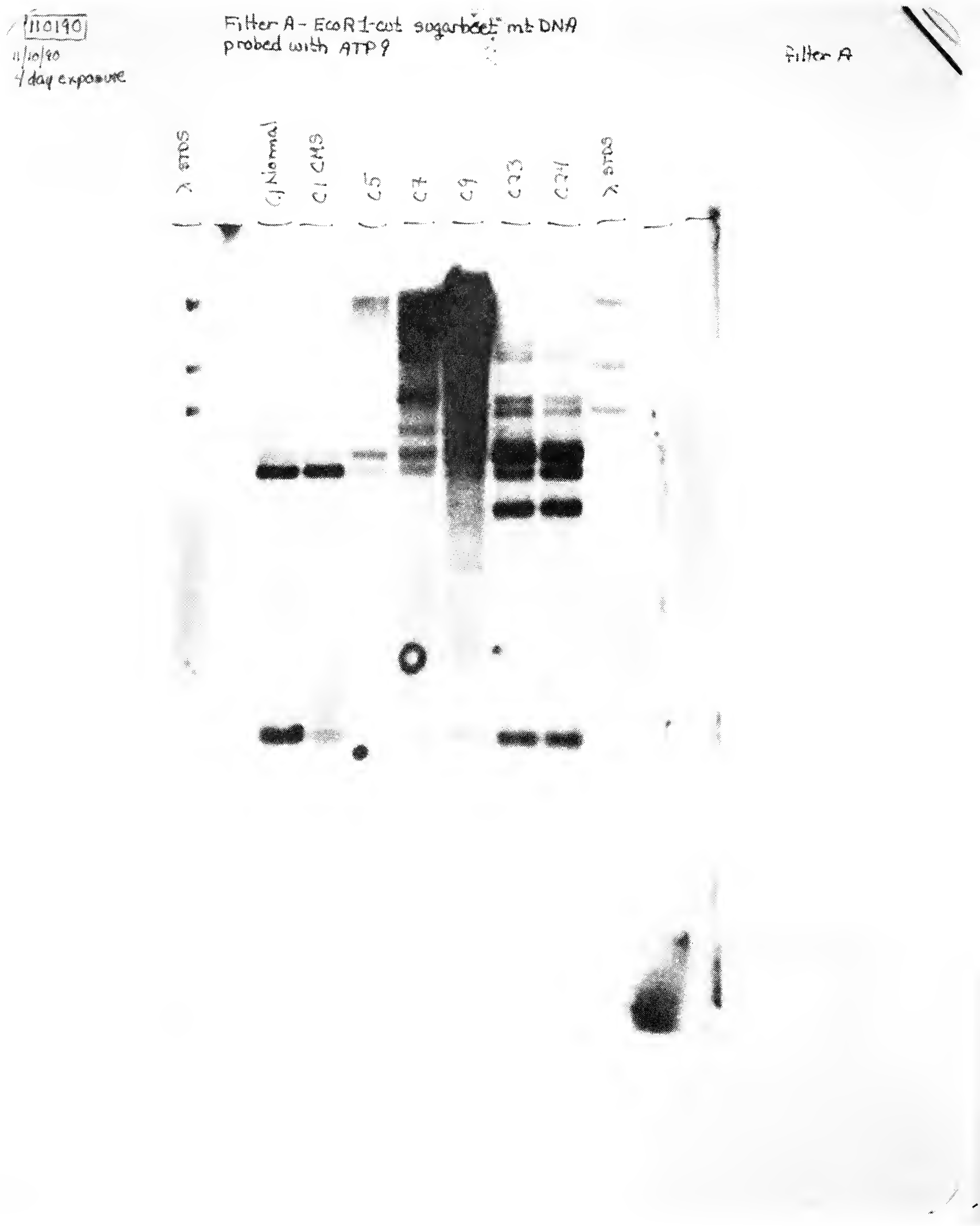
110190
11/10/90
4 day exposure
Filter A - EcoR1-cut sugarbeet mt DNA
probed with ATP9
Filter A
λ STDS
C1 Normal
C1 CMS
C5
C7
C9
C23
C24
λ STDS

FIGURE 3

MINIRHIZOTRON OBSERVATIONS FOR MHI E4 AND SR87 AT THREE PLANT DENSITIES

A. J. M. Smucker and J. C. Theurer

Two sugarbeet varieties, MHI E4 (standard) and SR87 (smooth root type), were planted in a Conover loam soil in East Lansing, MI., at row spacings of 25, 40, and 55 cm to observe the growth of fibrous roots and root turnover. Three minirhizotrons were installed in a center row of each 4-row plot. There were 4 replications in the experiment. Seedling beets were thinned to 25 cm between plants within the row. Weed control was maintained by hand pulling. The sugarbeet plants showed a deficiency in nitrogen during the months of May and June, and were side dressed with urea the first week of July.

Fibrous root growth was measured at biweekly intervals using a small microvideo color camera. The number of roots and the root turnover was determined by special programed microcomputer analyses of the data. A sample of 15 beets from the opposite end of the plot from where the minirhizotrons were installed was harvested on August 13 to compare the growth of different parts of the sugarbeet.

RESULTS

At 84 days after planting (DAP), plant size was significantly larger in the 40 and 50 cm row widths than in the 25 cm width (Table 1). Fresh weight of petioles at 25 cm spacing and dry weight of petioles and leaf blades at all spacings were greater for MHI E4 than for SR87. MHI E4 also had significantly larger dry weight of taproots than SR87 at the 25 cm spacing. There were little differences in the yields and quality at final harvest in October, which was no doubt a result of N deficiency early in the year. The sucrose percentage of SR87 was 1 - 2% lower than for MHI E4 at each row spacing.

The growth and development of roots were influenced by both variety and row spacing (Figures 2-5). Taproots had grown to depths of 80-100 cm during the first 52 days of growth. These data suggest an average taproot growth of 1.5 - 2.1 cm/day. Variety MHI E4 appeared to produce more fibrous roots than SR87 at 52 DAP for all row spacings, especially at the 55 cm row width, where 30-60% more roots were observed for this variety in the upper 40 cm of the soil profile (Figures 2A, 3A, and 4A). Root growth for MHI E4 appeared to be greater than for SR87 through 123 DAP for the 55 cm row spacing. However, this trend was not consistent at the 25 and 40 row spacings for the period from 93 - 123 DAP (Figures 2, 3, and 4). Greater root turnover rates also occurred in the upper 60 cm of the soil profile for the MHI E4 variety from 52 - 93 DAP (Figure 5). The rate of root turnover was quite variable for the 2 varieties at the narrower row spacings during the period from 93 - 123 DAP. Greater numbers and turnover rates of the fibrous roots occurred when the sugarbeets were planted at the 55 cm row spacing.

Table 1. Plant growth responses of MHI E4 and SR87 in three row spacings on August 13 (84 DAP). Conover loam soil at Michigan State University Agronomy Farm. 1991.

Row Spacing	Leaf Blades Fr. wt.	Leaf Blades Dry wt.	Petioles Fr. wt.	Petioles Dry wt.	Tap Root Fr. wt.	Tap Root Dry wt.
cm	g					
			MHI E4			
25	811 bc*	89 c	487 c	34 d	1024 bc	161 bc
40	1249 a	151 ab	702 ab	58 b	1390 ab	204 abc
55	1379 a	160 a	843 a	71 a	1583 ab	236 a
			SR87			
25	605 c	55 d	322 d	18 e	701 c	93 d
40	1060 ab	107 c	575 bc	42 c	1174 abc	150 cd
55	1286 a	134 b	809 a	61 b	1709 a	220 ab

* Duncan's multiple range test - means with same letter suffix are not significantly different at 0.05.

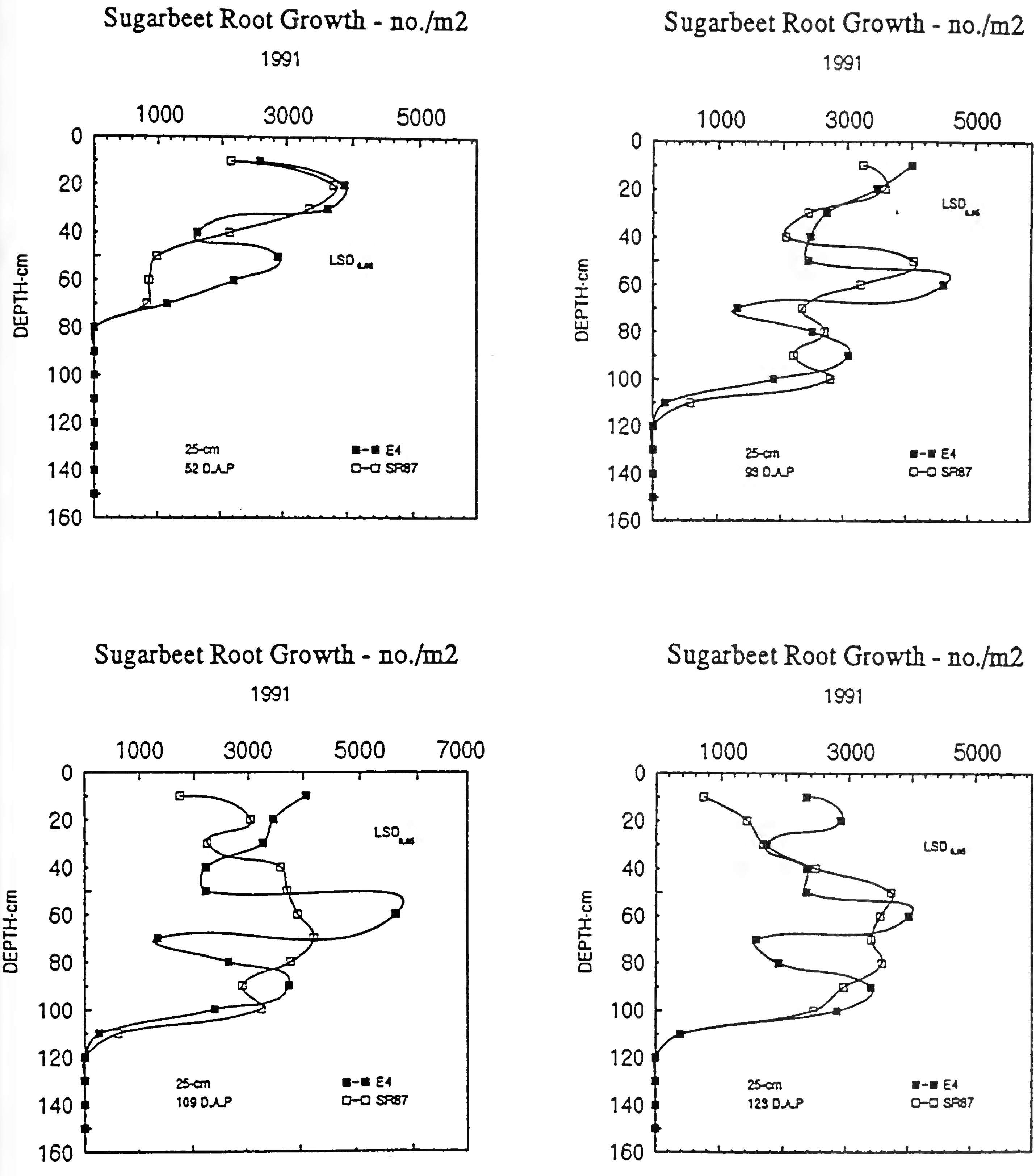

Figure 2. Sugarbeet root growth responses of two varieties planted at 25 cm row spacings for the period from 52 - 123 days after planting (D.A.P.) on a Conover loam at the M.S.U. Soils Research Farm, 1991

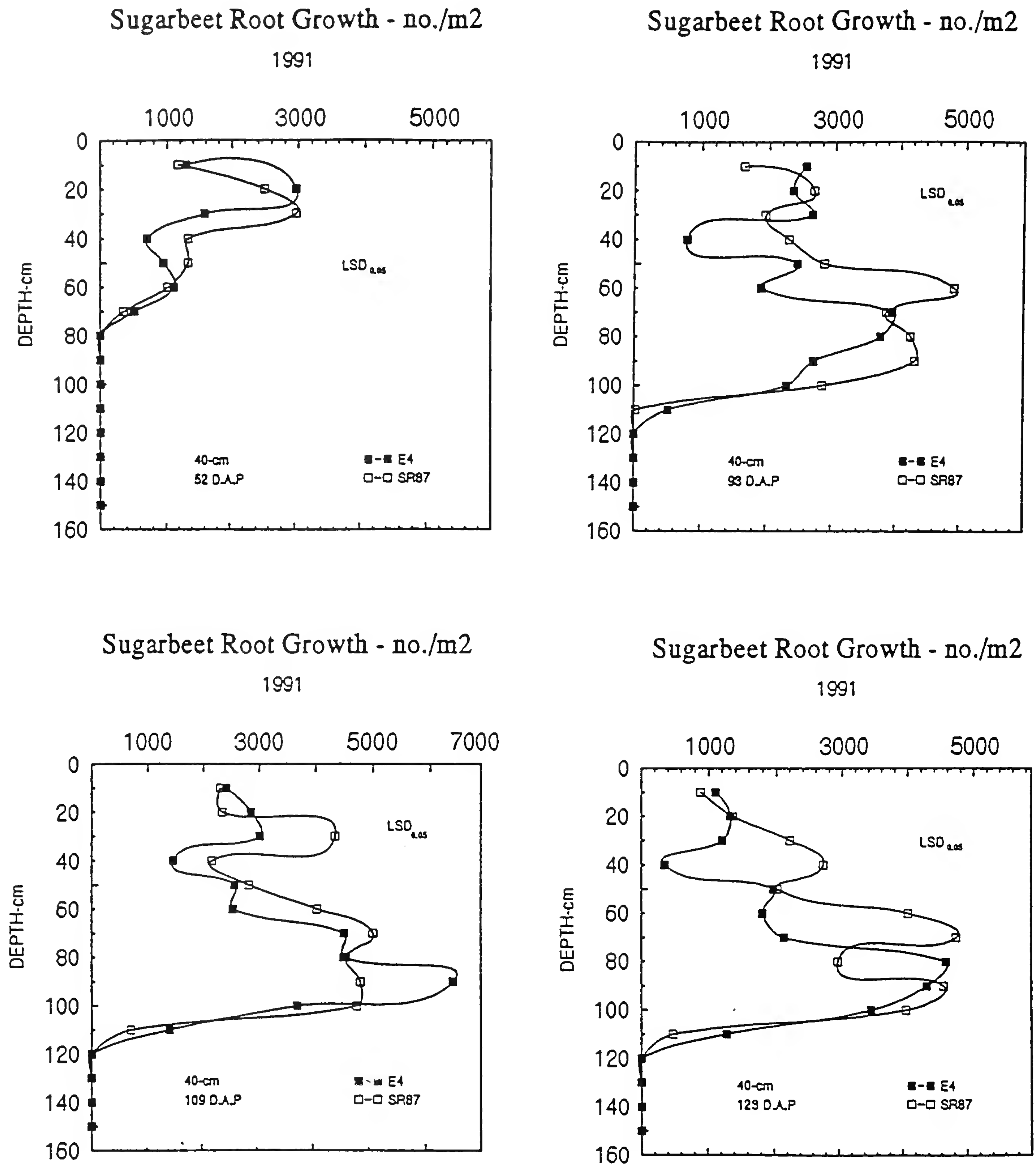

Figure 3. Sugarbeet root growth responses of two varieties planted at 40 cm row spacings for the period from 52 - 123 D.A.P.

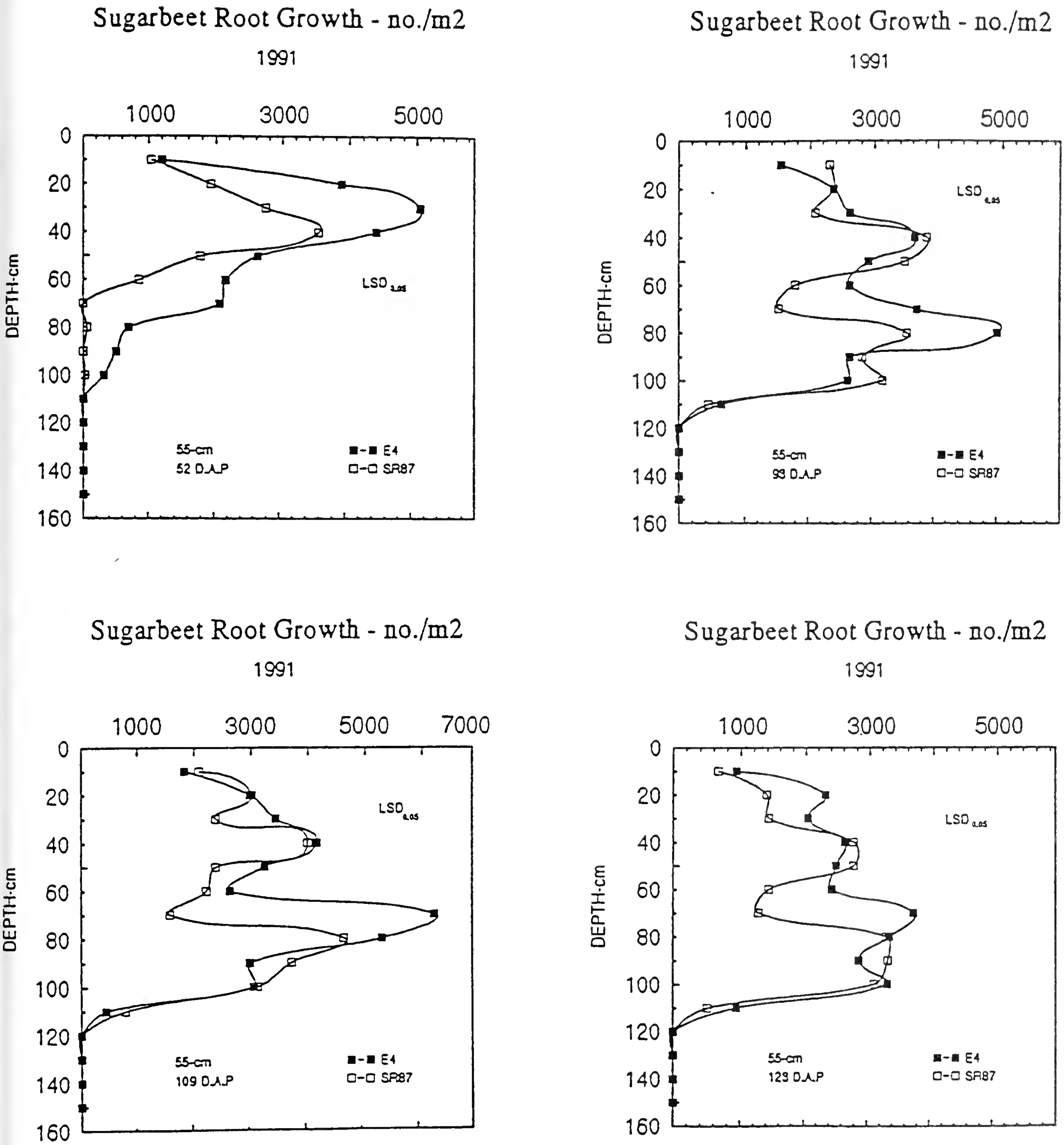

Figure 4. Sugarbeet root growth responses of two varieties planted at 55 cm row spacings for the period from 52 - 123 D.A.P.

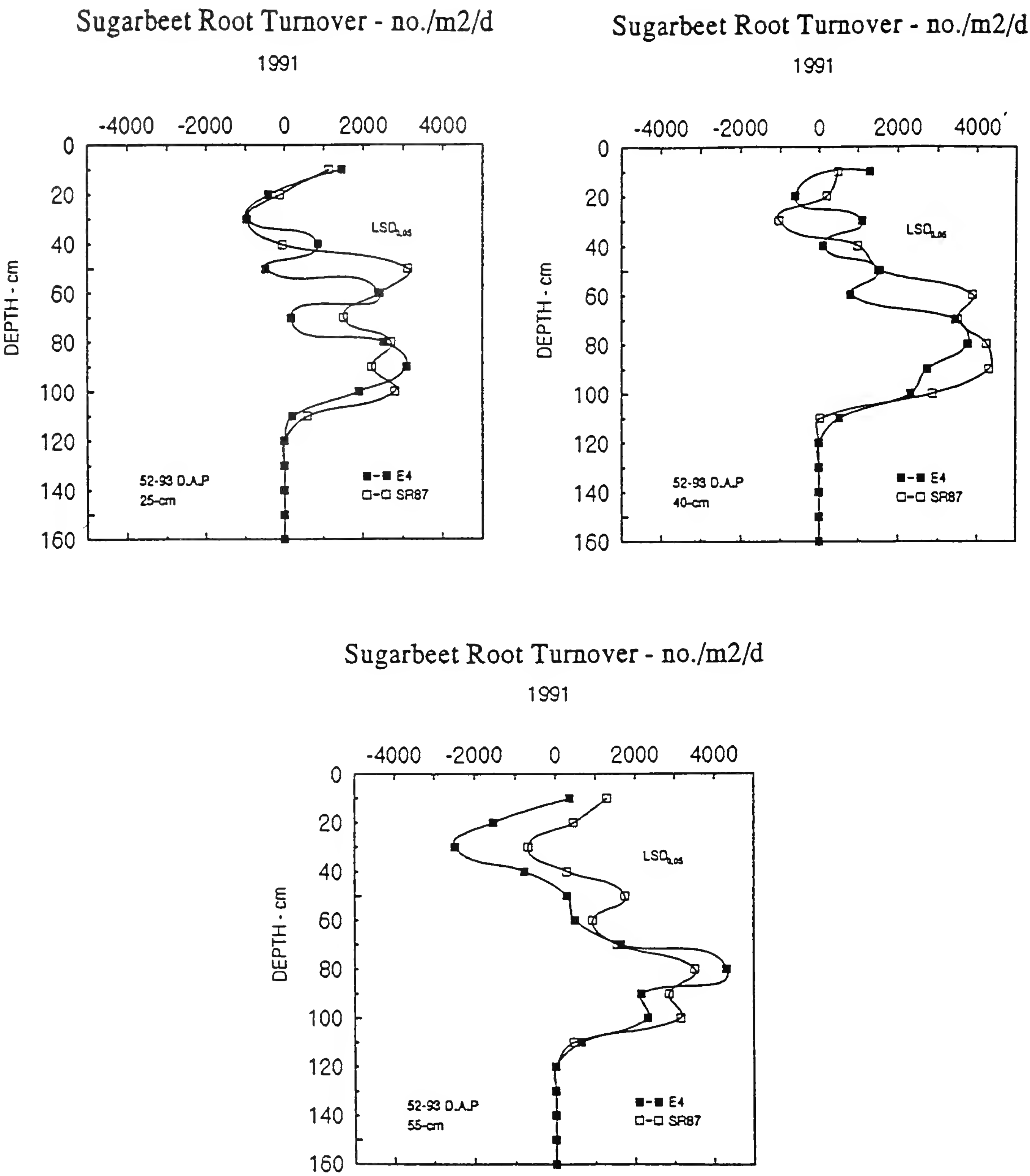

Figure 5. Sugarbeet root turnover rates for two varieties planted at 25, 40 and 55 cm row spacings for the period from 52 - 93 D.A.P.

RHIZOCTONIA ROOT ROT EVALUATION FOR COMMERCIAL AND EXPERIMENTAL HYBRIDS AT EAST LANSING MI. 1991

J. C. Theurer, L. Hubble and J. H. Halloin

Eighteen hybrid varieties were evaluated for their resistance to Rhizoctonia root rot in the disease nursery maintained at E. Lansing, MI. The natural source of inoculum in the soil was supplemented with an application of ground millet infected R. solani, which was applied to the crowns of the beets just prior to layby. The roots were dug by hand in early November and scored for disease on a scale of 0 = no infection lesions to 4 = dead plant. This year, the infection in the nursery was rather light. The same procedures were followed as for previous years, but for some unknown reason, good infection did not develop. For the most part, varieties had similar ranking for disease resistance in 1991 as observed in 1990 (See 1990 Bluebook Report, p. E11). However, Beta 5315 and Beta 5639 ranked higher, s and Beta 5435 and MH E4 ranked lower in 1991 compared with 1990 observations.

Table 1. 1991 Commercial Variety Rhizoctonia Evaluation, USDA Disease Nursery. East Lansing, MI.

	Variety	Average Score	% Crown Rot
1	ACH 197	2.06 abcd	51.5 abcd
2	ACH 185	1.76 bcd	43.9 bcd
3	ACH 176	1.87 bcd	46.6 bcd
4	USH23 (Susc. Check)	2.17 abc	54.2 abc
5	SXIIOI	2.10 abcd	52.4 abcd
6	MH E4	1.59 bcd	39.7 bcd
7	MH E9	1.81 bcd	45.3 bcd
8	MH E10	2.31 abc	57.6 abc
9	BETA 5315	2.12 abcd	53.0 abcd
10	BETA 5435	1.71 bcd	42.7 bcd
11	BETA 5639	2.11 abcd	52.9 abcd
12	BETA BG4603	2.87 ab	71.7 ab
13	ACH 86-1353	1.34 cd	33.4 cd
14	ACH 86-1350	1.57 bcd	39.2 bcd
15	UNIVERS	2.85 ab	71.4 ab
16	MONOHIKARI	3.25 a	81.2 a
17	HM 5135	2.23 abc	55.8 abc
18	KW 2398	2.70 abc	67.5 abc
19	FC 607	2.31 abc	57.7 abc
20	FC 501/5(Res.Check)	0.78 d	19.5 d
	Mean	2.08	51.9
	LSD 0.05	1.14	28.5
	CV	38.8	38.8

CONTENTS

SUGARBEET RESEARCH

1991 REPORT

Department of Energy, Plant Research Laboratory,
Michigan State University
East Lansing, Michigan

Dr. A. D. Hanson[A], Plant Physiologist
Dr. K. F. McCue[B], Molecular Biologist

[A]Present address: Institut de recherche en biologie végétale, 4101 rue Sherbrooke Est, Montréal, Québec H1X 2B2, Canada.

[B]Present address: Plant Gene Expression Center, USDA/ARS/UC Berkeley, 800 Buchanan Street, Albany, California 94710, USA.

This research was supported in part by funds through the Beet Sugar Development Foundation (Project 730).

PUBLICATIONS

Abstracts of papers published or submitted for publication.

McCue, K.F. and Hanson, A.D. 1992. **Regulation by Soil Salinity of the Expression of Betaine Aldehyde Dehydrogenase in Leaves: Investigation of Hydraulic, Ionic and Biochemical Signals.** Australian Journal of Plant Physiology (Submitted for publication).

Betaine aldehyde dehydrogenase (BADH) catalyses the last step in glycine betaine synthesis, and is induced several-fold by salt stress. To investigate this induction, BADH enzyme activities and mRNA levels were analyzed in leaves of salinized sugar beet plants (*Beta vulgaris* L.). In plants which had adjusted osmotically to growth at various NaCl concentrations, the steady state level of enzyme rose almost linearly between 0 and 500 mM NaCl, whereas that of BADH mRNA reached a plateau at 100 mM NaCl. Following a salt shock (transfer from 0 to 400 mM NaCl) BADH mRNA level first decreased for several hours, then increased; BADH enzyme activity rose slowly for several days. When salt was leached from the rooting medium of salinized plants, the level of BADH mRNA declined sharply with an apparent half-life of 2 h; enzyme activity also declined, but with a half life of more than 4 days. These data indicate (a) that transcription of the BADH gene or the stability of BADH mRNA in leaves responds far more dynamically to salinity changes around the root than does BADH enzyme activity; and (b) that the pattern of the mRNA responses is consistent with the participation of a non-hydraulic signal or signals coming from the root. The non-hydraulic signal is unlikely to be NaCl, because leaf disks exposed to salt concentrations typical of the apoplast of salinized leaves did not accumulate BADH mRNA. Some biochemical messenger is thus implied and, consistent with this, abscisic acid application to leaf disks elicited modest increases in BADH mRNA level.

McCue, K.F. and Hanson, A.D. 1992, **Salt-Inducible Betaine Aldehyde Dehydrogenase from Sugar Beet: cDNA Cloning and Expression.** Plant Molecular Biology 18:1-11.

Members of the Chenopodiaceae, such as sugar beet and spinach, accumulate glycine betaine in response to salinity or drought stress. The last enzyme in the glycine betaine biosynthetic pathway is betaine aldehyde dehydrogenase (BADH). In sugar beet the activity of BADH was found to increase two- to four-fold in both leaves and roots as the NaCl level in the irrigation solution was raised from 0 to 500 mM. This increase in BADH activity was paralleled by an increase in level of translatable BADH mRNA. Several cDNAs encoding BADH were cloned from a λgt10 library representing poly(A)$^+$ RNA from salinized leaves of sugar beet plants, by hybridization with a spinach BADH cDNA. Three nearly full length cDNA clones were confirmed to encode BADH by their nucleotide and deduced amino acid sequence identity to spinach BADH; these clones showed minor nucleotide sequence differences consistent with their being of two different BADH alleles. The clones averaged 1.7 kbp and contained an open reading frame predicting a polypeptide of 500 amino acids with 83% identity to spinach BADH. RNA gel blot analysis of total RNA showed that salinization to 500 mM NaCl increased BADH mRNA levels four-fold in leaves and three-fold in the taproot. DNA gel blot analyses indicated the presence of at least two copies of BADH in the haploid sugar beet genome.

Identifying and Manipulating the Enzymes and Genes for Betaine Synthesis in Sugarbeet.

Andrew D. Hanson and Kent F. McCue

Introduction:

Glycine betaine accumulates in sugarbeets and decreases the recovery of sugar from the expressed juice. The accumulation of glycine betaine is increased when sugarbeets are subjected to environmental stresses such as drought and salinity. Previous studies funded in part by the BSDF have helped to elucidate the biosynthetic pathway of glycine betaine in chenopods, and to clone the gene for the second enzyme in the pathway betaine aldehyde dehydrogenase (BADH) from sugar beet. This clone provides the basis for our attempts to understand the regulation of glycine betaine biosynthesis and to manipulate the pathway in an attempt to reduce betaine accumulation. We have used this clone to examine the regulation of the BADH gene in response to various chemical and environmental stimuli, and to repress the expression of the BADH gene using antisense technology which may reduce or eliminate betaine synthesis.

Results:

Kinetics of BADH gene and enzyme expression.

We have studied the effects of salinization, an osmotic stress known to induce betaine biosynthesis in sugar beet, on the levels of leaf solute potential, glycine betaine accumulation, BADH enzyme activity, and BADH mRNA abundance. All of these elements increase in parallel with increasing salinity in the irrigation medium (0 to 500 mM NaCl). The increases observed are all nearly linear with increasing NaCl concentrations with the exception of BADH mRNA levels. Upon salinization, the levels of BADH mRNA rise very rapidly, and reach a plateau at relatively low salt concentrations (100 to 200 mM), indicating an additional level of control between BADH gene expression and accumulation of the active BADH enzyme. These experiments have involved gradual salinization and represent steady state adaptation to osmotic stress, and do not reveal the kinetics of the response, or the nature of the signals involved.

Our latest studies have shown that although the levels of active BADH enzyme rise slowly upon onset of osmotic shock, and decrease slowly upon relief, the levels of BADH mRNA respond very rapidly. In both instances the initial osmotic shock causes a dramatic decrease in the levels of BADH mRNA. In the salt shock experiment, BADH mRNA levels decreased by over 50% in the first 6 to 12 hours, and recovered to non-stressed levels in 24 hours. The levels then continued to rise to a maximum at 3 to 5 days, while enzyme activity

reached a maximum after 7 to 9 days. In the reciprocal experiment, osmotic stress was relieved from plants gradually salinized to 400 mM NaCl, by irrigation with media without salt. Levels of BADH mRNA decreased within 4 to 5 hours to levels below those of the control, and slowly recovered to control levels after 24 to 48 hours. In contrast, the levels of BADH enzyme activity slowly decreased to control levels over a period of 5 to 7 days. Thus, the control of BADH gene activity, as judged by the abundance of BADH mRNA, is quickly affected by changes in the osmotic strength of the media. Although, betaine biosynthesis, as a result of BADH enzyme activity appears to be subject to additional regulatory controls at level of protein synthesis and degradation.

Regulation of BADH by hydraulic, ionic and chemical signals.

With the use of our cDNA as a probe of the transcriptional activation of the BADH gene, we have been able to ask questions in regarding the nature of the signals involved in the activation of the BADH gene.

Our *in vitro* assay has allowed us to examine various signals which are likely to be involved in the regulation of BADH using northern blot analysis of BADH mRNA isolated from leaf disks. In these experiments, total RNA is extracted from sister leaf disks taken from 6-week old sugar beet seedlings after treatment by floating for 24 to 72 hours in various control and test solutions.

The first signal we examined was NaCl at concentrations ranging from 0 to 100 mM, concentrations we have determined to be present in the apoplastic fluid of sugar beet leaves gradually salinized with 0 to 500 mM NaCl in the irrigation medium. Surprisingly, there was no significant effect of floating disk on NaCl solutions. The next experiment employed the use of abscisic acid, a naturally occurring plant hormone known to be involved in senescence and drought stress. ABA at physiological concentrations did show a significant effect on the relative abundance of the BADH mRNA levels above those of the control, although less than the induction observed in whole plants. Additional leaf disk experiments involved osmotic stress induced by wilting of leaves or by flotation on polyethylene glycol (PEG 4000). Both treatments caused significant but less dramatic results of maintaining BADH mRNA levels above those of the control.

In summary, we have been unable to show a direct effect of NaCl levels on the expression of BADH mRNA levels, while ABA, and treatments known to induce formation of ABA (wilting and PEG treatment) resulted in elevated levels of BADH mRNA abundance. Although, the induction by ABA suggests a role for this plant hormone in the regulation of BADH gene activity, the magnitude of the response indicates additional factors are also involved.

Manipulation of BADH gene activity by antisense.

The manipulation of betaine synthesis using antisense technology is the focus of the research funded by the Beet Sugar Development Foundation. In these experiments we are attempting to regulate the expression of the BADH gene, in order to reduce or eliminate the production of active BADH enzyme and hence glycine betaine biosynthesis. In antisense technology, the cDNA of the BADH gene isolated from sugar beet is transformed back into sugar beet in the "antisense", or inverted orientation. With this method, the gene is transcribed from the DNA in the opposite orientation from the endogenous BADH gene.

We have constructed as series of plasmids containing different parts of the BADH gene from sugarbeet inserted in the antisense orientation. The antisense gene is driven by the 35S promoter, taken from the cauliflower mosaic virus, and uses a 3-prime termination sequence from the *Agrobacterium* nopaline synthase gene. These transformation vectors are predicted to function in the plant to actively transcribe the antisense gene. These vectors have been prepared with the entire gene for BADH (derived from the cDNA encoding BADH isolated from sugar beet), as well the 5-prime half (750 bp), and the 3-prime half (1000 bp) of the gene. The constructs have been transferred to *Agrobacterium rhizogenes* from the intermediate host *E. coli* using direct transformation, and presence of the plasmids with the appropriate inserts has been verified.

Successful infection of surface sterilized petiole explants of sugar beet leaves with *A. rhizogenes* containing the various antisense constructs has resulted in the production of several cloned lines of "hairy roots". These roots have been cultured free of the bacteria and are being tested for levels of BADH enzyme activity. Preliminary results indicate that one of the transformed root clones is deficient in BADH enzyme activity. The initiation of hairy roots after *Agrobacterium* infection is based upon the endogenous root inducing plasmid. Transformation with the antisense gene requires a co-transformation with the endogenous plasmid and our engineered plasmid, so it is not unexpected that only a fraction of the hairy root clones express the antisense gene.

Future Goals:

The next step will be to analyze the levels of BADH enzyme activity in additional clones for altered levels of BADH activity. Clones which exhibit reduced BADH activity can then be used for the regeneration of plants to examine the effect of reduced betaine levels at the whole plant level. At this stage the desirability of reduced betaine on plant viability and beet development can be investigated. If this proves promising the long term goal would be to introduce this trait into sugarbeet breeding lines for further research.

SUGARBEET RESEARCH

1991 Report

Section F

University of Idaho
Idaho

Dr. S. L. Hafez
Dr. A. J. Anderson
Dr. J. J. Gallian

The research was supported in part by funds provided through the University of Idaho and the Beet Sugar Development Foundation.

CONTENTS

SUGARBEET CYST NEMATODE MANAGEMENT

Saad L. Hafez

The sugarbeet nematode can dramatically affect the growth and development of the sugarbeet plant. Severe nematode infestations have reduced root yields as much as 70 percent. It is a common practice for sugarbeet growers to spend $80 to $120 per acre for nematicides to control the pest. The availability of two of the most commonly used nematicides, Telone II and Temik, is in question since both compounds are presently under review by the Environmental Protection Agency and have come under attack recently by several environmental groups.

BASIC STRATEGIES FOR SUGARBEET CYST NEMATODE MANAGEMENT

Prevention
Cultural practices
Resistant cultivars
Nematode resistant catch crops
Chemical control

ACCOMPLISHMENTS

The Effects of different nematode resistant sugarbeet hybrids, oil radish or mustard on sugarbeet cyst nematode population.

Trap crops of oil radish and yellow mustard have been developed for control of the sugarbeet nematode. Trap crops are planted after small grain harvest in the summer and are allowed to grow until winter temperatures kill the crop. The development of the trap crop on nematode-infested soils triggers the nematode eggs to hatch. The nematode larvae enter the trap crop root but are not able to reproduce. The nematode population density in the soil is reduced and conditions are again favorable for sugarbeet production. The practice is presently being utilized on about 250,000 acres in Germany.

In several greenhouse and field studies, several nematode-resistant sugarbeet hybrids and nematode-resistant catch crops, oil radish Raphanus sativus oleifera and white mustard Sinapis alba, were tested in the greenhouse and commercial fields to evaluate their potential use in SCN integrated management program. Results showed that the percent of reduction in SCN population among different sugarbeet hybrids ranged from 50 to 89% of the initial population. Although these hybrids showed good level of resistance to the SCN, their agronomic characters are not acceptable. In different studies, two nematode-resistant oil radish varieties (Pegletta and Nemex) and white mustard var. (Maxi) were planted in sugarbeet fields heavily infested with SCN. Results indicated that Pegletta, Nemex and Maxi significantly reduced the number of SCN eggs by 67, 23, and 87% respectively. The control treatment, Fallow, reduced SCN eggs by 28% of the initial population. Table 1 & 2 showed the result of fall and spring planting of oil radish and mustard.

Table 1. The effect of FALL planting of oil radish (Pegletta) and buckwheat (Prego) on sugarbeet cyst nematode population. Dry Lake, ID. 191, Saad L. Hafez.

Crops	--- Nematode Population in 500 cc soil ---				% Reduction
	Before Planting 8/12/91		After Planting 12/4/91		
	V.C.*	Total E&L**	V.C.	Total E&L	
Oil Radish (Pegletta)	4.2	510.8	2.0	114.0	77.7
Buckwheat (Prego)	16.0	2,121.6	12.7	1,739.9	18.0

*V.C. = Viable Cyst
**E&L = Eggs and larvae
Planting date: 8/08/91
Plowing date: 10/17/91

Results of these studies indicated that resistant catch crops should be used as a part of integrated systems. Also different varieties of catch crops has different level of resistance (none of them are absolute).

Important conditions to increase the effectiveness of nematode-resistant catch crops on reducing S.B.C.N. nematode populations.

1. Dense planting and deep root penetration

2. Create optimum conditions for egg hatching (Temperature and moisture)

3. High resistant levels in the varieties

Table 2. The effect of spring planting of oil radish and white mustard on sugarbeet cyst nematode population. Parma, ID 1991, Saad L. Hafez

Crops	Nematode Population in 500 cc soil									% Reduction
	Pre-Planting 3/24/91			Post Planting 06/04/91			Post Planting 07/15/91			
	V.C.*	E&L/cyst	Total E&L	V.C.	E&L/cyst	Total E&L	V.C.	E&L/cyst	Total E&L	
Pegletta	18.0	178	3,204	12.2	108	1,318	8.0	134	1,072	66.5
Nemex	12.0	132	1,584	9.8	110	1,078	9.6	127	1,219	23.0
Maxi	8.0	168	1,344	11.0	111	1,221	1.6	108	173	87.1
No Plant	17.6	176	3,086	20.6	146	3,008	12.2	174	2,223	28.0

*V.C. = Viable Cyst
Planting date: 3/29/91
Plowing date: 7/16/91

Progress Report 1992. Beet Sugar Development Foundation Biological Control of Plant Pathogens

Anne J. Anderson, Utah State University and John J. Gallian, University of Idaho.

Our goal is to identify bacteria with biocontrol potential for pathogens of sugar beet seedlings. Studies have been directed at control of *Phoma betae*, a seedborne pathogen and *Rhizoctonia solani*, a soilborne organism. Because biocontrol agents must be competitive with the pathogen under field conditions our initial studies were to isolate the bacteria from sugar beet seeds and roots. Bacteria from these sources should have field competency under Idaho growing conditions.

Organisms were identified for their antagonistic activity *in vitro* against either or both of the pathogens. Of the nearly 100 bacterial isolates that were initially selected we have performed *in planta* studies with about 10 isolates that displayed good antagonism on the *in vitro* plate assays. The *in planta* studies have been conducted at a constant temperature of 25°C in greenhouse conditions. The seed was sterilized to kill existing microbes and planted into sterilized vermiculite with or without defined pathogenic and or bacterial inocula. The inocula consisted of 10^4 conidia of *Phoma* or 10^2 propagules of *Rhizoctonia* in a 50 ml volume containing 50 seeds. Bacteria were added to the seeds at 10^8 CFU/ml in all studies except as noted. Plants were grown under a 12 hr light/dark regime and emergence and seedling health was scored visually on a daily basis. The data are shown on the following Tables 1 and 2.

TABLE 1

Effect of bacterial treatment on emergence and disease in seedlings from *Phoma*-infected seed.

Treatment	% Emergence	% Healthy seedlings
Phoma alone	75 a	0 a
Group I		
Phoma +R 1-I-1	60 b	50 b
Group II		
Phoma +P1E	84 a	83 d
Phoma + P2E	82 a	73 c
Phoma + P5A	64 b	87 d
Phoma + P9D	82 a	81 d
Group III		
Phoma + R3L-2	75 a	76 c

Phoma + J2B3	75 a	25 b

Bacteria and *P. betae* were applied to sugar beet seeds prior to planting. Germination and seedling health were determined after 7 and 10 days of incubation. Data are expressed as the % germinated seeds relative to the number of seeds planted, and then the % of those seeds that germinated which grew to healthy plants. Data are the means from 3 batches each of 50 seeds; values followed by the same letter in a column are not different according to Duncans multiple range test at P=0.05.

TABLE 2 Effect of bacterial seed treatments on disease caused by *Rhizoctonia solani*

Treatment	Germinated Seeds	Healthy Seedlings	Survival %
Control	33[a]	32[a]	96
Rhizoctonia	17[b]	0	0
Group I			
Rhizoctonia + R1-I-1	19[b]	10[b]	53
Rhizoctonia + P8E	19[b]	16[c]	84
Rhizoctonia + R6	21[b]	8[b]	38
Group II			
Rhizoctonia + P1E	18[b]	11[b]	71
Rhizoctonia + P5A	21[b]	16[c]	76
Rhizoctonia + P9D	15[b]	9[b]	55
Group III			
Rhizoctonia + R3L-2	20[b]	12[b]	60
Rhizoctonia + J1A8	15[b]	10[b]	66
Rhizoctonia + J6B1	20[b]	18[c]	90

Seed was treated with water as a control or inoculated with *R. solani* or *R. solani* plus bacteria. Data are the results after 10 days of 3 studies each of 40 seeds; Values followed by the same letter in a column are not different according to Duncans Multiple range test at p = 0.05.

% survival calculated from the ratio $\frac{\text{healthy seedling x 100\%}}{\text{germinated seeds}}$

Good control of both *Phoma* and *Rhizoctonia* was measured with several of the isolates. Inoculation with isolates P1E, P5A and P9D in studies with *Phoma* resulted in a seedling stand of about 80 % whereas all of the control plants which lacked a bacterial inoculum were killed. With *Rhizoctonia*, these same bacterial isolates also gave good control. Other isolates P8E and J6B1 gave slightly better control of *Rhizoctonia*.

To more closely approximate field conditions in which the *Rhizoctonia* inoculum is present in the soil, sugarbeet seed was vacuum infiltrated with bacteria, sown in vermiculite into which *R. solani* mycelium had been added. Emergence was recorded seven days after sowing and incubation at 25°C. Emergence in the treatments was 22% to 59% greater upon treatment with bacteria selected from Group I, II and III than the control seeds exposed to the pathogen only (Table 3).

Table 3. Emergence of sugarbeet seedlings treated with selected isolates of biocontrol bacteria and planted in vermiculite infested with *Rhizoctonia*

Treatment	Emergence	% above *Rhizoctonia* treatment
R3L-2	3.9 a	44
P1E	3.8 a	41
R1-I-1	4.3 a	59
P9D	3.3 ab	22
No inocula	3.8 a	41
Rhizoctonia	2.7 b	

R. solani mycelium from 12 day old potato dextrose broth liquid culture was ground and added to vermiculite at 0.006 g per pot. Seed was infiltrated with 10^6 to 10^8 CFU/ml suspensions of bacteria. Values are means of 5 seeds/pot, 5 pots/treatment, replicated four times. Values followed by the same letter are not different according to Duncan's Multiple Range Test, P=0.05.

Selected bacteria with biocontrol potential were field tested at the University of Idaho Research and Extension Center at Kimberly. Seed were inoculated with *Phoma* and the biocontrol agents in the same manner as in the greenhouse studies. Emergence counts indicate that little disease resulted from the *Phoma* inoculum (Table 4). Consequently it was not possible to determine whether there was a protective effect of the bacterial inocula.

Table 4. Field emergence of sugarbeet seed inoculated with *Phoma betae* and beneficial bacteria.

Treatment	Emergence per 25 foot row/100 seed
P9D	64.8
P1E	62.5
R1-I-1	62.5
R3L-2	59.3
Phoma only	58.3
Phoma + P9D	59.0
Phoma + P1E	52.0
Phoma + R1-I-1	30.5
Phoma + R3L-2	58.0
Phoma + Apron + Thiram	69.5
Untreated	62.3
Water control	59.3
LSD 0.05	12.1

100 seed per row, six row plots, 25 ft long, replicated 4 times. Values are means of emergence counts for the 2 center rows/plot.

The same bacterial isolates were tested for activity against *Rhizoctonia solani* at the University of Idaho Research and Extension Center at Parma in a field severely infested with *Rhizoctonia solani*. Seed were inoculated with bacteria only and planted on April 25. Emergence was recorded on May 23 and plants were dug and rated for *Rhizoctonia* infection on August 6 (Table 5). Grain was subsequently planted next to our plots, resulting in some stress to the sugarbeets from shading. Consequently, these plants were not as vigorous as normally would be expected and plots displayed variability. A moderate to high disease rating was recorded, and little effect of treatments with the chemical fungicides Apron and Thiram or bacteria was observed.

Table 5. Field emergence and *Rhizoctonia* root rot disease rating of sugar beet in response to seed inoculation with biocontrol bacteria.

Treatment	Emergence per 10 feet of row	Disease Rating
P1E	37.2	4.4
R1-I-1	36.8	6.0
P9D	34.9	4.7
R3L-2	28.5	5.1
Apron-Thiram	35.8	4.0
Untreated	33.0	4.9
Water Control	31.6	4.8
LSD 0.05	6.8	1.1

Disease ratings: 1 = no disease; 7 = plant dead. 100 seed planted per single row plot 25 ft long, replicated 4 times.

The data from both field plots were interesting with isolate R1-I-1. In the presence of the pathogens *Phoma* or *Rhizoctonia* this bacterium appears to enhance the pathogen's effects measured as emergence for *Phoma* and as disease rating with *Rhizoctonia*. Isolate R1-I-1 produced HCN and incites an hypersensitive response in bean and tobacco. Whether these traits are responsible for or involved in the deleterious interactions of R1-I-1 with the sugar beet pathogens is being studied. These data stress the need for bioassays of each possible isolate and indicate that not every plant-associated microbe that shows antagonism toward pathogens in culture will have a beneficial function in the field.

The bacteria were grouped in to three types dependent on their pigmentation on agar medium. Group I and II isolates were all fluorescent pseudomonads whereas Group III were mixed genera. The organisms were identified by mass spectral /GC analysis of their fatty acid compositions. Their designations are denoted in Table 6.

TABLE 6 Isolate characterization by GC/mass spectral analysis

Group I	
R1-I-1	*P. aureofaciens*
R6	*P. aureofaciens*
P8E	*P. aureofaciens*
Group II	
P1E	*P. tolaasii*

P2E	*P. tolaasii*
P5A	*P. tolaasii*
P9A	*P. tolaasii*
P9D	*P. tolaasii*

Group III

R3-L-2	*Serratia*
J2B3	*Enterobacter*
J1A8	*Bacillus subtilis*
J6B1	*Bacillus subtilis*

We have initiated studies to uncover the antagonistic principles involved in the highly effective Group II isolates which are classified as *P. tolaasi*. These bacteria when cultured on potato dextrose agar in the presence of the pathogen produced an intense green- brown pigment. This pigment resembles the pigment produced by *P. fluorescens* 2-79, an organism which is an effective antagonist of the fungus that causes take-all in wheat. The pigmentation in 2-79 has been attributed to the secretion of a phenazine derivative, 1,3, phenazine carboxylic acid (PCA) which has antibiotic activity. We have purified the PCA from culture filtrates of 2-79 by procedures in the literature. We have demonstrated that this yellow pigment moves with the same RF as the yellow pigment extracted from culture filtrates of the *P. tolaasi* strains upon thin layer chromatography. The purified PCA from 2-79 and the yellow compound from each of the *P. tolaasi* strains are readily soluble in chloroform and displayed the same absorbance characteristics with maxima at 279 and 350nm. These data suggest that the biocontrol active Group II isolates are producing PCA. A role for PCA in the antagonism of both *Phoma* and *Rhizoctonia* is strengthened by our observations that both *Phoma* and *Rhizoctonia* are inhibited *in vitro* by 2-79 but not by a mutant B-46. The B-46 mutant was derived by Thomashow et al. and is deficient in PCA production. These data suggest that phenazine production may be an important feature of antagonism against the sugar beet pathogens displayed by certain of the fluorescent pseudomonads. We have observed that other antagonistic bacteria in Group I and in Group III do not produce PCA. However additional materials which absorb in the UV are detected in culture filtrates of these antagonistic bacteria and the antibiotic potential of these compounds is being tested.

SUGARBEET RESEARCH

1991 Report

Section G

Texas Agricultural Experiment Station
Bushland, Texas

Dr. C. M. Rush
Dr. G. J. Michels

Cooperation:

Imperial Holly - Hereford, Texas

The research was supported in part by funds provided through the Texas A&M University and the Beet Sugar Development Foundation (Project 500, 502 and 520).

CONTENTS

Vaughn, K, M. and C. M. Rush. 1991. Reducing Aphanomyces seeding disease of sugar beets by limited irrigation. 1991 APS Annual Meeting, St. Louis, MO, August 17-21, 1991.

One of the most common seedling diseases of sugar beets in the Texas Panhandle is caused by *Aphanomyces cochlioides*, a zoosporic fungus. A study was conducted to determine if this seedling disease could be reduced by irrigation and/or seed treatments. In a greenhouse study, unprimed, unprimed+Tachigaren, solid matrix primed (SMP), and SMP+fluid seed treatments were planted in boxes that were pre-irrigated and artificially infested with oospores of *A. cochlioides*. Half the boxes were then irrigated post-plant. Seedlings from SMP and SMP+fluid seed treatments emerged faster than unprimed nontreated seed, but after 6 days there was no significant difference. No seed treatment affected disease incidence, however, irrigation treatments did. In post irrigated boxes, average seedling disease was 56%, but in pre-irrigated boxes only 5%.

Rush, C. M. and R. D. Martyn. 1991. Variation in sugar beet susceptibility to isolates of *Fusarium oxysporum* f. sp. *betae* from Texas and Oregon. 1991 APS Annual Meeting, St. Louis, MO, August 17-21, 1991.

Isolates of *Fusarium oxysporum* f. sp. *betae* from sugar beets in Texas are morphologically and genetically distinct from those from Oregon. It was unknown whether these differences related to pathogenicity, so a study was conducted to determine if sugar beet germplasm reacted differently to Fusarium isolates from Texas and Oregon. Seed from 90 entries were planted and later seedlings were inoculated with each pathogen using the tray dip method. Poor seed quality resulted in erratic seedling emergence and only 60 entries were evaluated for disease severity, and top and root weight. When data was sorted by isolate, high variability resulted in little difference in disease rating among entries. However, 16 entries differed significantly in their susceptibility to the two isolates with nine more resistant to the Texas isolate and seven more resistant to the Oregon isolate. Fourteen entries had a disease rating value ≤ 1.2 on a 0-3 scale. Root and top weight were highly correlated to disease rating.

Rush, C. M. and K. M. Vaughn. 1991. <u>Relation of root rot severity to sugar beet quality parameters</u>. 1991 APS Annual Meeting, St. Louis, MO, August 17-21, 1991.

A study was conducted to evaluate the effects of Aphanomyces and Rhizoctonia root rot on sugar beet quality. Beets were collected from 15 fields during 1990 harvest, and beets from each field were separated into disease severity categories 0-4, with 0=healthy and 4=severely rotted. Multiple subsamples were then taken from each category and evaluated for sucrose content and impurities. From these, loss to molasses was calculated. Sugar loss from beets in each disease category was analyzed using regression analyses. As disease severity increased, percent sugar decreased significantly $r=.79$ ($\underline{P}=0.05$), but impurities and loss to molasses were not correlated with disease rating. The relation between disease severity rating and sugar loss was best described by the equation, percent sugar loss = .43 rating^2, $R^2=.89$, $\underline{P}=0.0001$. Compared to healthy beets, total recoverable sugar was significantly reduced in disease severity categories 2 through 4. The type of root rot did not affect these results.

Heidel, G. B., C. M. Rush, and R. E. Mock. 1991. Preliminary studies on the incidence of beet necrotic yellow vein virus and beet distortion mosaic virus in Texas. 1991 APS Annual Meeting, St. Louis, MO, August 17-21, 1991.

Beet necrotic yellow vein virus (BNYVV), a soilborne virus, was found in Texas in 1985. Beet distortion mosaic virus (BDMV) was reported in 1987. Currently, no information on the incidence of either virus in Texas is available. 160 soil samples were collected from two counties. Sugar beet seed was planted in two replications of each sample. After 9-10 weeks, root tissue was serologically assayed for BNYVV. At least one replication was positive in 29% of samples tested. Both replications were positive in 13% of samples. In a second study, beets with rhizomania symptoms were collected from eight fields. Veinal yellowing and necrosis, symptoms associated with systemic BNYVV infection, were observed in leaf growth from defoliated beets. Particles similar to both BNYVV and BDMV were observed by electron microscopy in leaf dips. Leaf tissue extracts reacted positively by ELISA against BNYVV antiserum.

Rush, C. M. 1992. Stand Establishment of Sugar Beet Seedlings in Pathogen Infested Soils as Influenced by Cultivar and Seed Priming Technique. Plant Disease (in press).

A greenhouse study was conducted to determine whether selected sugar beet (*Beta vulgaris L.*) cultivars responded differently to various seed priming techniques. Priming techniques included osmopriming with -1.5 MPa NaCl or -1.2 MPa PEG 8000, and solid matrix priming (SMP) with water and a hydrous silicate clay mineral as the solid substrate. Washed and nontreated seed were used as controls. Treated seed of cultivars Ach146, Ach177, HH42, and Tx9 was planted in a silt loam plus peat soil mix artificially infested with *Aphanomyces cochlioides, Pythium ultimum,* or noninfested. Seedling emergence and damping off were recorded daily. Although varying in degree, all cultivars responded similarly to the different seed treatments. There was typically no seed treatment x cultivar interaction with any of the recorded variables at any time. All priming treatments increased the rate and uniformity of seedling emergence, and also reduced the incidence of preemergence damping off in soils infested with *P. ultimum*. There was a small but significant, positive correlation between T50, i.e., the weighted mean time for emergence of all seedlings, and preemergence damping off (R^2 = .23, $P \leq 0.05$). As T50 increased (i.e., slower emergence), preemergence damping off increased. *Pythium ultimum* caused both preemergence and postemergence damping off; however, *A. cochlioides* caused only postemergence damping off. Although priming treatments reduced preemergence damping off, no treatment significantly reduced postemergence damping off.

COMBINING SOLID MATRIX PRIMING WITH BIOCONTROL AGENTS TO ENHANCE BIOLOGICAL CONTROL OF SUGAR BEET SEEDLING DISEASES

Kathy M. Vaughn and Charles M. Rush

Plant diseases caused by soilborne pathogens often result in economic losses in crop production. Control of many different plant pathogens is strongly dependent on the use of chemicals. However, sufficient control of plant diseases are not always achieved with the use of pesticides. The need to develop alternative measures for disease control has become a priority for many research programs.

Biological control is a promising approach for disease reduction and can be used in combination with other systems. For advancement of biocontrol technology, improved methods of preparation and application of antagonistic microorganisms are necessary.

Solid matrix priming (SMP) is a physiological seed treatment in which hydration is controlled through matric potential, and improves the rate and uniformity of seedling emergence. Little research has been done concerning the integration of biocontrol agents with solid matrix priming to control soilborne pathogens. In 1989, G.E. Harman and A.G. Taylor, at Cornell University, tested different bacterial strains and their interaction with solid matrix priming seed treatment on a range of crops and pathogens. Results indicated there is potential to improve biological seed treatments by combining effective biocontrol agents and solid matrix priming. However, little of no work has been done with sugar beets. Therefore, our research objectives are to identify bacterial or fungal strains capable of reducing sugar beet seedling pre- and postemergence damping-off caused by *Rhizoctonia solani* and to evaluate the combination of solid matrix priming with biological control agents to reduce seedling diseases caused by soilborne pathogens.

All bacterial and fungal isolates were selected because of previous reports of antagonism against soilborne plant pathogens. In preliminary testing, six bacterial isolates were tested for their ability to control damping-off caused by *R. solani*. Bacterial strains *Pseudomonas cepacia* (AMMD) and *Pseudomonas fluorescens* (PRA25), from J.L. Parke, and *Enterbacter cloacae* (E.C.), from C.R. Howell, showed promising results for possible disease control. These three isolates were combined with solid matrix priming to test their ability to reduce damping-off caused by *R. solani*.

Screening of fungal biocontrol agents to suppress *R. solani* will include *Gliocladium virens*, strains Cr-4, G-3, and G-9, from C.R. Howell, and strain GL-21, from G.C. Papavizas. Preliminary testing will begin when preparations concerning growth of fungal isolates has been accomplished.

MATERIALS AND METHODS

Storage of pathogen and biocontrol agents. Isolate R-26 of *R. solani*, anastomosis group AG-4, was isolated from diseased sugar beet seedlings and maintained on barley.

Bacterial isolates were stored in 80% glycerol vials in the freezer at -15 to -20 C, while fungal isolates Cr-4, G-3 and G-9 were maintained on millet at 5 C, and G-21 on potato dextrose agar at room temperature.

Seed priming. The solid matrix priming technique used in these studies, and devised by John Easton (U.S. patent #4,921,874), is a procedure in which a dry hydrous, silicate clay is mixed with equal portions of seed and sterile DI water, incubated for 3-5 days at a controlled temperature on a rotator machine, and then air dried at room temperature.

Combining biocontrol agents with SMP. Bacterial strains were grown in NBY broth at room temperature, and after 48 hours NBY agar plates were inoculated with 2.5 ml spore suspension and incubated at room temperature for 24 hours. Sugar beet seed was inoculated with bacteria during the priming process.

Planting materials and seed treatments. The soil mixture used consisted of sterile field soil and sand, 1:1 ratio. Five barley kernels colonized with *R. solani* were used to infest soil in pots, measuring 13 cm x 11 cm.

Two studies were conducted to test the efficacy of seed treatments against R-26. The first study contained 11 seed treatments, planted in infested and noninfested soil, with 3 replications. Seed treatments consisted of 3 bacterial isolates (AMMD, PRA25, and E.C.) added during the priming process, 3 bacterial isolates added to primed (SMP) seed, 3 bacterial isolates added to nonprimed seed, SMP control, and nonprimed control. The second study consisted of 5 seed treatments, 3 bacterial isolates added during the priming process, SMP control, and nonprimed control. In the second study, seed treated with bacteria during priming received a higher bacterial concentration than did the same seed treatments in the first study. Additional treatments were omitted in this study because the main point of interest was whether an increase in bacterial concentration would significantly reduce disease. Serial dilutions were performed to determine bacterial populations for both studies. Experiments were conducted in an incubator at 21 C. Seedling emergence and pre- and postemergence damping-off of sugar beet seedlings were recorded.

RESULTS AND DISCUSSION

Seedlings from SMP seed treatments showed a more rapid emergence than nonprimed seed treatments, in infested and noninfested soil. In the first study, adding bacteria during the priming process did not significantly improve disease control. However, in the second study, with higher bacterial populations applied during priming, AMMD/SMP seed treatments significantly reduced disease. In both studies, seedlings from E.C./SMP

seed treatment exhibited a possibility of phytotoxicity. However, no other seed treatments displayed this problem.

Bacterial populations did not proliferate during the priming process as expected. In some instances with certain biocontrol agents, populations were reduced by the SMP process. Reasons for this are unclear and will be investigated in future study.

Once methods and procedures have been developed to our satisfaction, biological seed treatments will be tested against other soilborne fungi, such as *Aphanomyces* and *Pythium*.

Developing Laboratory Techniques for Rearing the Sugarbeet Root Aphid *Pemphigus Betae* Doane

A Report of Research Sponsored by the
Beet Sugar Development Foundation 1991

Project Number 520

by

G. J. Michels, Jr., R. L. Deerberg, K. M. Vaughn, and B. J. Thompson

Texas Agricultural Experiment Station
6500 Amarillo Blvd. West
Amarillo, Texas 79106

The sugarbeet root aphid *Pemphigus betae* Doane is a heteroecious aphid, exhibiting two life cycles involving cottonwood trees, *Populus* sp., as its primary host and herbaceous plants such as sugarbeets, *Beta vulgaris* L., as its secondary host. Most damage is done to the sugarbeet when its water and nutrient uptake are interfered with as a result of the aphids feeding on the secondary roots. Both yield and sugar content can be reduced.

The majority of the studies conducted have involved the life cycle of the sugarbeet root aphid in relationship with its primary host. Little research has been done concerning the life cycle of the root aphid while living on sugarbeets.

If sugarbeet root aphids can be reared in a controlled environment in a laboratory, more specific information about their life cycle on the secondary host can be obtained. Therefore, the objectives are to develop *in vitro* techniques for rearing sugarbeet root aphids and observing their growth and reproduction cycles while on the sugarbeet.

MATERIALS AND METHODS

We investigated different methods for rearing sugarbeet root aphids *in vitro* using petri dishes (100 x 15 mm). Sections of sugarbeet taproot with intact secondary roots were treated with different concentrations of sodium hypochlorite (Chlorox), rinsing three times with sterile deionized water, or fungicides and then subjected to a number of different water agar media containing antibiotics and fungicides. Aphids from infested sugarbeets were transferred to the beet sections via a paintbrush

moistened with sterile water. The plates were kept on a lab bench at room temperature.

Different water agar solution plates, as previously mentioned, were lined with sterile circles of filter paper or sections of plastic biohazard bags to allow the aphids to roam around more freely. The circles fit over the agar allowing the beet section to be placed directly on the agar for its nutrient source. These beet sections were also treated as previously mentioned. Aphids were transferred to the beet section and kept on a lab bench at room temperature.

A moist, sterile soil mixture contained in petri dishes was used to maintain young sugarbeets about 2 to 4 months old. 400 g of sieved field soil was mixed with 70 ml sterile deionized water, covered, and autoclaved 15 minutes. Beet leaves were removed at the crown and the entire sugarbeet root was used. Beet roots were not subjected to any treatments other than washing 15 minutes with tap water. Working under a laminar flow hood, the sugarbeets were patted dry using sterile paper towels and individually placed in sterile petri dishes containing soil. The plates were wrapped with parafilm.

Aphids were retrieved from an infested sugarbeet field. Sometimes the aphids were dipped in a 1% sodium hypochlorite solution for 10 seconds before being transferred to sugarbeet plates, and other times the aphids were transferred directly from infested beets to sugarbeet plates. Since the first objective was to develop a method for rearing the aphids *in vitro*, we were not concerned with separating the aphids according to their different growth stages. The number of aphids transferred to each plate ranged from 5 to 25 aphids per plate. The plates were sealed with

parafilm. At first the aphid plates were kept at room temperature on a lab bench, subjecting them to light and cooler temperatures at night, but then we decided to keep the aphid plates in a dark incubator at about 26 C. The progress of the aphids were checked periodically using a microscope. Data concerning soil appearance, beet growth and appearance, and aphid reproduction were recorded. Whenever the soil lost too much moisture causing the sugarbeet tissue to degrade, the aphids were transferred to fresh sugarbeet plates and stored properly.

RESULTS AND DISCUSSION

The first two methods using the different water agar solutions as a nutrient source for sugarbeet sections contained in petri dishes were not successful. The aphids were not able to move about freely on the media without getting trapped, nor was mycelial growth sufficiently inhibited by the media solutions or beet treatments. Also, fungicides that were used to treat beet sections had a tendency to discolor the beet tissue. Using sterile circles of filter paper and biohazard bags helped somewhat to alleviate the problem of aphids getting trapped in the agar, but there was still the problem of mycelial growth which was possibly due to the exudates produced when the beets were cut.

We decided a more natural environment would be conducive for rearing aphids. To avoid exudates caused by injury or cuts to the root, the entire taproot of the sugarbeet was used. Dipping the aphids in sodium hypochlorite was time consuming, and there were no indications that the beet-aphid plates containing the dipped aphids performed better than those plates in which the aphids were not

dipped. The sugarbeets retrieved enough moisture and nutrients from the soil to start producing new, delicate, white roots and regrowth at the crown. These were good signs that the beet was continuing to grow and develop, at least for a short time period.

At first, when the beet-aphid plates were kept at room temperature on a lab bench, the aphids response to their environment was not as anticipated. The aphids started to form wings. We were not sure the reasons for this, but thought that temperature and light might be major factors. Consequently, the beet-aphid plates were moved to a dark incubator at a controlled temperature of 26 C. This eliminated the winged phase.

For the most part, the aphids responded well to their new environment. However, the beet-aphid plates varied in performance. Some aphids responded very well to their environment and reproduction rate was high, while other aphids responded poorly and died or seemed to disappear from the plates. Also, some beets remained healthy longer than others. Again, information was recorded concerning the growth and reproduction of the aphids, and the overall appearance of the beet and soil.

The time period that the aphids were kept in the beet-aphid plates varied. Aphids were transferred to new beet plates when the reproduction rate was high, about 50 to 100 plus aphids per plate, or when the sugarbeet tissue started to degrade, not supplying the aphids with enough food. The time that the aphids could survive and reproduce in the beet-aphid plates varied, 1 to 2 months.

Presently, we have accomplished our first objective and have developed a technique for rearing sugarbeet root aphids *in vitro*. We have enough aphids at this point to start studies for monitoring the growth and reproduction cycle responses to different temperature regimes.